THE ARTIZAN:

A Monthly Record

OF THE PROGRESS OF

CIVIL AND MECHANICAL ENGINEERING,

SHIPBUILDING, STEAM NAVIGATION, THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS, &c., &c.

EDITED BY W^M. SMITH, C.E.

VOL. XVI., FROM THE COMMENCEMENT.
VOL. X., NEW SERIES.

LONDON:
PUBLISHED AT THE
OFFICE OF "THE ARTIZAN" JOURNAL, 19, SALISBURY STREET, STRAND. W.C.
1858.

T1,A8

LONDON:
KELLY AND CO., PRINTERS, OLD BOSWELL COURT,
ST. CLEMENT'S, STRAND.

INDEX TO VOL. XVI.

THE ARTIZAN JOURNAL, 1858.

LIST OF PLATES.

TO THE BINDER.

Plate CXV., Gun Boring Machine, to face title page.

NOTICE TO ANNUAL SUBSCRIBERS.

IN accordance with the notice addressed in the December Number by the Proprietor to the Readers of THE ARTIZAN, inviting them to send in their names as Annual Subscribers, very many have promptly responded to the invitation; and it is hoped that the number of Annual Subscribers will be very materially increased, so that the improvements which have been contemplated in connection with the Journal may be fully carried out.

Every Annual Subscriber will in future be entitled each year to receive free a Proof Impression, printed on thick Plate Paper, of any one of the Engravings which have been published during the last three years, or of any which may hereafter be published in THE ARTIZAN; and he may also obtain any additional number of Proof Impressions at the following prices:—

Quarto plates, 1s. each; double quarto, 2s.; and any larger size, at 3s. each. India Proofs will be charged double the above prices.

Annual Subscribers, paying in advance, to whom these privileges are alone extended, in availing themselves thereof, must, at the time of applying, *produce the receipt for their subscription*, or supply the *printed consecutive number of their receipt*, whereupon the Plate which they may have selected will be delivered to them at the Publishing Office.

The Offices of "THE ARTIZAN" are now Removed to 19, SALISBURY STREET, STRAND. W.C.

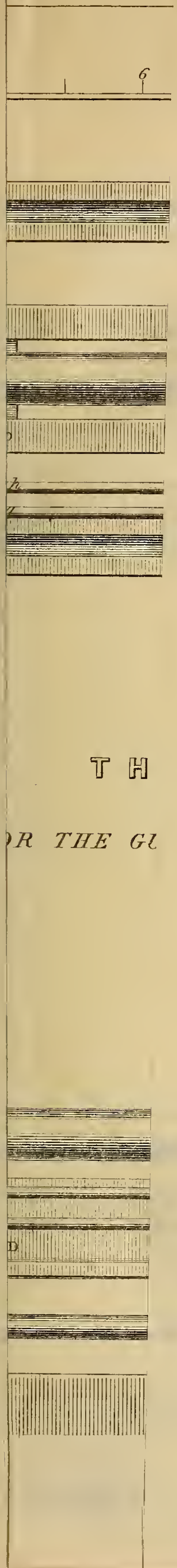
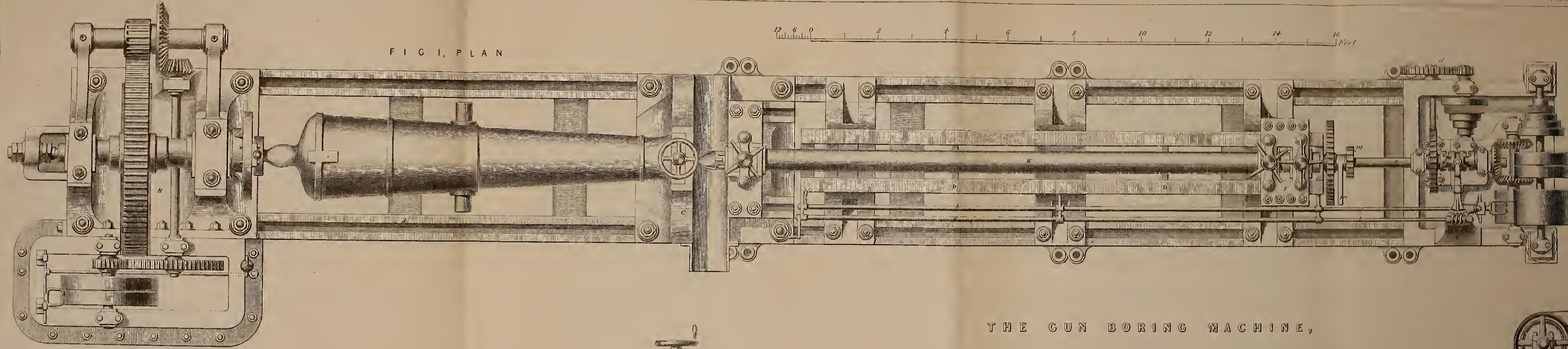

6
h
T H
R THE GU
D

FIG 1, PLAN.

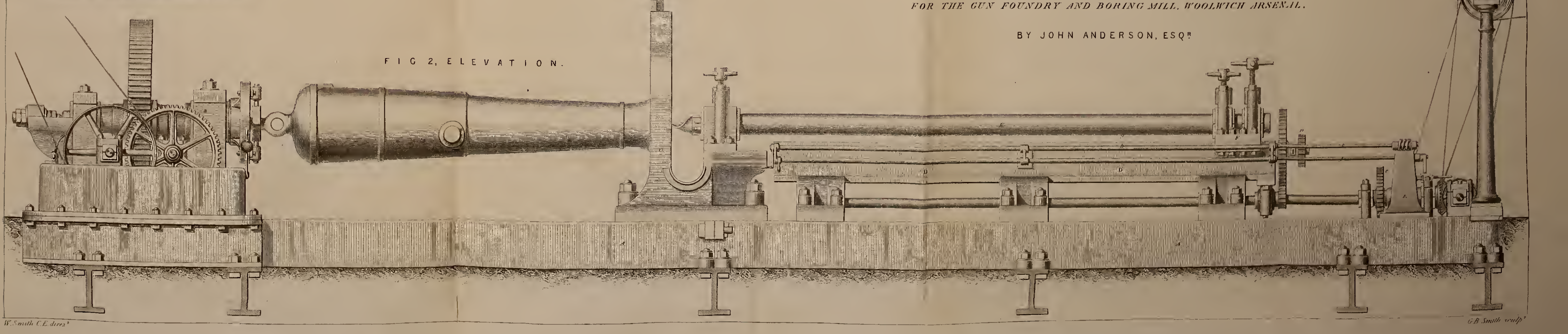


THE GUN BORING MACHINE,

FOR THE GUN FOUNDRY AND BORING MILL, WOOLWICH ARSENAL.

BY JOHN ANDERSON, ESQ^{R}

FIG 2, ELEVATION.



W. Smith C.E. direx^{t}

G.B. Smith sculp^{t}

THE ARTIZAN.

No. CLXXX.—Vol. XVI.—JANUARY 1st, 1858.

"ARTIZAN" ADDRESS, 1858.

"According to ancient custom," we again avail ourselves of the opportunity annually afforded us of thus addressing a few words to our Readers; and pleasurable as are our ordinary duties in relation to them, such opportunities as the prescut—which "Old Time" in his onward march affords us—are doubly pleasant.

Upon the present occasion—the passing away of the year 1857—we regret our inability to record it as a year of great plenty, of commercial prosperity, or of extraordinary progress in the arts, the sciences or manufactures; nor as a period which can be recorded on the Scroll of Time as one in which great mechanical and scientific achievements have been successfully performed to the astonishment of the world, for the material advancement of science, or for the lasting benefit of mankind; and hence the extent which our observations might otherwise have occupied is necessarily thereby limited.

Without stopping to detail all the disappointments and failures connected with those branches of Science, Art, and Industry, to which our Journal is devoted, we will merely allude to the two most prominent—viz., the want of success which has attended the attempts, to lay the Atlantic Telegraph Cable, and to launch the *Great Eastern* steam-ship (named by *mistake*—we mean by Miss Hope—the *Leviathan*), and then pass on to other events of the year, which must, as a whole, be taken as a set-off to these disappointments.

We have taken advantage of the opportunities which the termination of the war with Russia gave us, of accumulating national strength, and are preparing ourselves against future events, and in the mechanical and material resources requisite for both army and navy, we are making rapid strides for the purpose of placing ourselves as a nation in advance of all others in the extent and power or capabilities of our armaments, naval and military. Although in these departments disappointments or failures to a greater or lesser degree have occurred in connection with great guns, monster mortars, and fast frigates, yet the knowledge we have thus acquired, has, we hope, been made available for substantial progress and practical improvement; and we are glad to find that at least one department of the Government—the War Department—has treated inventors of reputation and known ability in a more liberal and encouraging spirit than heretofore; and it is only, by holding out suitable inducements that men who are not visionary schemers and speculators, can afford to expend time and money in following out scientific investigations and experiments on a large scale, which alone are of any practical value in connection with works of naval or military defences.

We last year referred to the improvements which had been introduced into the Public Works' Department in the East India Company's Service, by the appointment of civil instead of military engineers in each of the Presidencies, and we have been much gratified to learn that the system has been found to answer admirably; and it is much to be regretted, that the outbreak of the Sepoy mutinies should have paralysed the progress of public works throughout India. The construction of railway works has been very materially interfered with, and for a time, to a great extent, ceased. The extension of the telegraph system within India, the construction of roads, the building of bridges, the cutting and construction of anicuts, canals, and other such works, and even the maintenance and improvements of existing canals and water-courses, has for some time past ceased to employ the attention of the officers charged with such works, and an immense amount of labour has from this cause been thrown out of employment; indeed, works of improvement have, for the present, almost entirely throughout India, been suspended: but we trust this interruption to the great schemes of improvement which have been sanctioned will very shortly cease, and that these important works will be speedily resumed; for we feel assured that it is only by opening up the country throughout its length and breadth, and connecting every station with head quarters, by improving its numerous rivers and navigations, and by intersecting it with available canals and lines of railway communication, that we can hope to hold India without a ruinously extensive and expensive army.

There is, however, an extensive engineering work in India which is nearly completed, and has recently had public attention called to it, as possessing not only a local importance, but as serving also to mark the advent of a new era in the management of India: we allude to the extensive works for the supply of Bombay with water; works which are said to reflect great credit upon Mr. Conybeare, C.E.

The result of the approaching completion of the symmetrically proportioned but enormously large specimen of iron shipbuilding, the *Great Eastern*, has, as we anticipated in our Address last year, given a strong impetus to the desire for ships of considerably greater carrying capacity and power than those ordinarily employed for long voyages; and we have recently witnessed in our waters, the last great specimen of naval architecture and engineering which our Transatlantic cousins have produced, and which, in turn, it is said, will be eclipsed by a vessel about to be laid down for employment between the same ports.

The rivalry between iron and wooden construction for commercial ships, progresses steadily; and it is anticipated that during the year 1858, considerable headway will be made in the construction of iron ships of large tonnage: and as there is some probability of Captain John Ford's proposal for the establishment of a line of Australian, India, and China steam ships of large tonnage, being carried out, we hope to see another step taken in the right direction, and the practical experiments made which will settle the question of the advantage of large ships over small ones, for the Eastern and other long voyage trades.

The construction of screw steam colliers is increasing rapidly, both as to number and size of the ships; and it is gratifying to observe the great strides which have been made in improving the construction of this class of vessel.

It is seriously to be hoped that iron shipbuilders will in future guard themselves against the charge of using inferior iron to that which they contract to supply, and that only materials of the best quality, bearing the name and mark of the *actual* maker upon every plate and bar shall be used in the construction of iron ships; for, upon this will depend the favour in which iron ships will in future be held, and the chances of the extension of this system of construction will be materially impaired by a want of this honesty and proper conservative principle.

Whilst dealing with the subject of naval architecture, and the kindred questions, we would note the recent trials of the *Diadem* screw steam frigate, 32 guns; and take this opportunity of suggesting to the Department of Naval Construction at the Admiralty, that the principles upon which private contractors for steam ships and engines conduct their business, might be advantageously adopted by that department of the Admiralty, and a proper association of that department with the steam branch would doubtless prevent the disappointments which constantly arise upon their attempting anything which has not been already done. It behoves the designers of intended fast steaming screw war-vessels to acquaint themselves with the particular forms of both fore and after lines suited to the application of the screw as a propelling agent, and that bow lines, at least as fine as those now commonly given to screw colliers, *should* belong to such a vessel as the *Diadem*, but wanting which, the Steam Department of the Navy, and the constructors of the engines and machinery have not been permitted a fair opportunity for the display of the exact knowledge which science and practice combined have enabled *them* to bring to bear upon that in which they engage.

We notice with pleasure the adoption by the East India Company of iron gun-boats of very light draft of water, propelled by high-pressure

engiues and screws; and in the trials of the first of these, which we record in the present Number, no disappointment has been felt in the results; and in this respect, too, they bear honourable comparison with the want of success which ordinarily pertains to this class of Admiralty experiments; and we hope very shortly to hear that the projected steam flotilla of gun-boats will be actively employed on the Indian rivers and inland waters.

The most iuteresting event of any moment connected with high speed steam propulsion will, we anticipate, take place during the summer of 1858, when it is expected that two of the new express steamers will be on their stations, running between Holyhead and Kingstown; and we trust that the new boats will be able successfully to comply with the requirements of the service, and perform the distance at least a quarter of an hour within the time in which the ruu is to be made.

The Holyhead and other harbour works, and similar engineering undertakings in Great Britain, have progressed slowly but steadily during the past year.

In bridge building, amongst those abroad, we notice that the progress made in connection with the Great Victoria Railway Bridge in Canada is said to be very satisfactory, aud that the Cologne Railway Bridge for crossing the Rhine is being proceeded with rapidly. Amongst the constructions of this kind in course of erection in Great Britain, we have to notice that the works have receutly been recommenced in connection with the new Westminster Bridge, aud they are now being pushed on with vigour. The elegant suspension bridge, which spans the Thames at Chelsea, is nearly completed, and its appearance reflects credit on all concerned. Mr. Brunel's combined suspension and elliptical tubular girder bridge, consisting of two main spans of 455 ft. each, for carrying the Cornwall Railway over the Tamar at Saltash, is approaching completion, one of the tubes having recently been successfully got into place.

Descending from the great to the small—we cannot resist the inclination to write "from the sublime to the ridiculous"—we notice the abortion, which, uuder the name of a suspension bridge, is a disgrace to its designers and a disfigurement to St. James's Park, over the canal in which it has receutly been erected.

The excavation of Mount Cenis Tunnel is being proceeded with; and we may in the course of a few months be better able to judge of the advantages attendant on the employment of machinery for excavating or cutting tunnel galleries and similar works; and it is expected, should success attend the present experiments, that the employment of machinery for this purpose will materially iufluence the extension of the railway system in various parts of the world.

In the construction of the permanent way of railways, progressive improvements are being effected; and whilst cast-irou sleepers and chairs find favour, and the direction which such constructions are taking, show the importance of a perfectly framed and combined system of iron construction, it is evident that it can ouly be made perfectly successful by the interposition between the chair and the sleeper of some permanently elastic material, which will be unaffected by changes in the atmospheric condition and influences which tend to destroy by rendering rotten most of the materials which have heretofore been employed for the purpose. The introduction of such a material, beyond rendering the road comparatively noiseless, would give to it a character of permanence which no timber-sleepered road cau by possibility attain, and also remove entirely the objections which belong to the various systems of iron sleepers.

The application of steam power to hauling goods on canals has not, during the past year, received as much attention as it deserves; for, although high speeds can never be advantageously obtained upon the narrow and shallow canals of this couutry, the economy of steam power, as compared with animal power for hauling goods on canals, has not yet been properly developed.

The Great Suez Ship Canal scheme continues to meet with the dogged opposition of the Great Politicals of this country, who have by some means or other induced a great engineering celebrity, who stands at the head of the profession, to express an opinion, unfavourable to the project in an engineering sense. This is much to be regretted, as it is not by obstructive policy, and the expression of unfairly-grounded opinions, that any great engineering work has heretofore been supported and successfully carried out.

The extension of the Submarine Telegraph system throughout the world, particularly in the Mediterranean, has been progressing rapidly during the year; and although the attempt to lay down the Atlantic Telegraph Cable has disappointed the expectations expressed in our Address for 1857, we still hope that the means which the engineers entrusted with that operation have now adopted will insure the successful completion of the great link which is alone wanting to enable those in almost any part of the great continent of North America to communicate with every part of Europe, or *vice versâ*.

The Indian Telegraph system, it is confidently expected, will shortly be in communication with the European network of telegraphs, by means of submarine cables extending from Suez to Kurrachee. The Mediterranean portions of the system are being rapidly completed.

Agricultural engineering has, during the past year, received considerable attention; and the employment of steam power for the tillage and treatment of land is being very fully tested under a variety of systems, and with marked success. Boydell's Tractive Engine, with its continuous and self-carrying system of shoes or rails, as improved by Messrs. Tuxfords, now bids fair to realize what was anticipated from its introduction.

The extension of the system of draining agricultural lands is telling beneficially upon the productive capabilities of this country; and it is worthy of note, that the labours of Mr. Josiah Parkes, C.E., in thus improving West Indian properties, are likely to be eminently successful in rendering highly productive land which, for want of complete and systematic drainage, was previously not available for growing sugar crops, or, if under cultivation, was liable to inundation, and the destruction of the crops thereon. And it cannot be too strongly impressed upon the proprietors of British West India estates, that it would be much more creditable for them to avail themselves of the advancement which science has enabled agricultural engineers to make in the modes of rendering available and fertile the most unpromising of soils, instead of continually complaining of the competition of the slave-holding sugar growers, and sighing for a return to the system of importing slave labour, which practice, it is to be hoped, will never again disgrace British rule.

The attention of locomotive engine builders have for a long time past been called to the importance of constructing the furnaces of locomotive boilers that coal may be substituted for coke as a fuel, wherein perfect combustion could be effected, and with a view to avoid the objections to which the use of coal in locomotive boilers is open; and this object has, to some extent, been effected; but we suggest that it is worthy of the attention of those who are engaged in the coustruction of locomotive boilers for coal-burning engines, to consider more fully the effect which the combustion of coal has upon the parts of boilers as ordinarily constructed; and we think it would amply repay those who are interested in the introduction of coal-burning locomotive engines to study fully the cause of the boiler explosion which a short time ago occurred on the South Western Railway.

The Great Metropolitan Drainage Scheme, after twelve months of wordy passages between the Chief Commissioner of Works and the Greek Street Board, seems to leave the question very much in the same position in which it formerly was, and the chances of the general scheme being commenced during the year 1858 appear somewhat remote.

The award of the premiums offered for designs of subways for the Metropolis does not seem to have given satisfaction, although the invitation was responded to very extensively, and produced many excellent designs.

Notwithstanding the monetary crisis which has been felt throughout the whole of Europe and America, and that its effects may, for another month or two be perceptible in England, as affecting the projection of new undertakings involving large amounts of capital, civil engineers will find ample employment during the year 1858.

Mechanical engineers should, during 1858, look to the Continent of Europe for orders, and prevent their going into other channels. The pressure in monetary affairs exists chiefly amougst commercial circles, and will very soon pass away, and money be again plentiful. Some of the foreign Governments are, however, actively engaged in increasing the number of their steam war ships.

English locomotives, too, are in high favour and request abroad; but it has been remarked, "that engineers do not travel as much as formerly."

We have already far exceeded the limit which we proposed for the extent of our Address upon the present occasion, and must now take leave of our Readers. Before doing which, however, we take the opportunity of adding a few words with reference to The Artizan; and to economise space, we would refer to the concluding paragraph in our Address, 1857, and merely repeat, that, whilst we hope for not only a continuance, but also an extension of that support which has been afforded to the Journal, more particularly during the last year, we desire to call the attention of our Readers to a notice which was addressed to them by the Proprietor in The Artizan for December last, and also to a further notice which will be found elsewhere in the present Number; and we should be wanting in our duty, and in the respect we have for the interest alike of the Proprietor of The Artizan and its Readers, if we did not strongly recommend the suggestions therein made for their immediate adoption, as being emineutly advantageous to Subscribers.

THE "GREAT EASTERN" STEAM-SHIP (OR "LEVIATHAN").

The efforts which were last made to force this ship down the ways having, unfortunately, beeu unsuccessful, a cessation of the attempts occurred about a fortnight ago, since which time various additions have been made to the means before employed, and additional abutments have been piled in closer to the ship, and numerous powerful hydraulic presses have been put into position, and it is expected that all the

arrangements will have been completed by the time—or shortly after—our present Number is in the hands of our subscribers. We have, therefore, determined again to postpone the publication of our notice of the arrangements employed for launching the ship, to admit of the necessary alterations and corrections being made in the drawing and the textual matter, which are alone required to render complete the description of the ship, her machinery, and arrangements, which have, from time to time been published in THE ARTIZAN, which is the only published work that contains a reliable, accurate, and scientific description of this novel and extensive undertaking.

MACHINERY OF THE WAR DEPARTMENT.

THE NEW GUN-BORING LATHES ERECTED AT WOOLWICH FOR BORING LARGE IRON ORDNANCE.

(Illustrated by Plate cxv.)

WHEN we last month gave a description of the brass cannon turning and boring lathes, which a few years ago were introduced into Woolwich Arsenal, and which are now employed, we promised to describe the large gun-boring lathes which are now being erected in the New Gun Foundry and Boring Mill at Woolwich, for boring the large pieces of cast-iron ordnance which the War Department have decided in future to cast for themselves, instead of being entirely dependent upon contractors as heretofore.

It will be in the recollection of most of our readers, that scientific Commissions, composed of civil and military engineers, mechanics, and chemists, were, during the last five years, sent by the Government to various foreign countries to investigate the systems of founding cannon, and the manufacture of ordnance and small arms, followed in those countries respectively. The valuable results of the investigation of the latter of the subjects mentioned, have been the establishment of a very extensive and complete Small Arms Factory at Enfield; and more recently, the valuable collection of data resulting from the investigations connected with the former, has been productive of a similar advantage to the Ordnance Department of the Government and to the country, in obtaining the erection of an extensive iron foundry, wherein the experience thus gained may be practically and profitably applied in the production of ordnance of the largest and most powerful description, and of a quality greatly superior to the ordnance heretofore cast in this country.

Since the several scientific Commissions returned home, a vast number of practical experiments have been performed with various qualities of English iron, and with other irons, the productions of various countries, and in the compounding or mixing of various qualities of iron, in various proportions, with the view of ascertaining the respective merits of such metals and their compounds, for the purpose of casting ordnance of a maximum strength for a given weight of metal, and capable of resisting, for the longest time, the effects of use and the damage to which the percussive force of the powder, at the instant of explosion, had upon the breech or chamber portions, as also its resistance to the damaging action of the passage of the projectile along the tube, and to the other influences to which ordnance is subjected in actual warfare.

These experiments, it is anticipated, will prove of great practical advantage, not only in the manufacture of ordnance, but also in throwing considerable light upon the questions involved in the use and application of cast iron in very many branches of the iron industry of the world; and we are mainly indebted to the scientific and practical attainments of the Inspector of Machinery to the War Department, Mr. John Anderson, and the Chemist to the War Department, Mr. F. A. Abel, of Woolwich Arsenal, for the very important results which have already been derived from these investigations.

We present our readers this month with a drawing of the Gun-Boring Lathes which are being introduced into the new boring mill lately erected in the Royal Arsenal, Woolwich.

Eighteen of these lathes are now in course of construction in the Gun Factories Department.

The general arrangement of the lathe will be seen by reference to Figs. 1 and 2, Plate cxv. Fig. 1 is a plan and Fig. 2 an elevation; these, with the several other views which will hereafter be given,* render it almost unnecessary to offer any description.

The bed, A, is bolted to cast-iron girders, which are placed transversely under the boring lathes; the upper surface of the bed, A, is flush with the floor line, and is filled in with concrete both within and without the beds.

The spindle of the driving headstock, B, carries the breach end of the gun by means of a piece cast beyond the cascable; this piece is previously prepared in another machine so as to fit into a cone in the end of the lathe spindle: between this prepared extremity and the gun there is also a square cast, upon which is placed the carrier.

This carrier is made the weakest part of the lathe, in order that it may break in the event of any obstruction arising calculated to damage the machine or the boring apparatus.

The collar frame, C, which carries the muzzle, is provided with a vertical adjustment; to it also is fastened an adjustable bearing for the boring-bar, as will be seen by Figs. 3 and 4.

The boring apparatus, D, consists of a lathe-bed, which is secured to the bed, A, by means of three standards. Both the frame, C, and the apparatus, D, are adjustable on the bed, A, by means of a self-acting arrangement of the boring apparatus, so as to suit guns of different dimensions.

The gear-box, E, which is bolted to the end of the bed, A, contains all the motions required for the boring bar; and the countershaft, *a*, which is placed above, contains the driving pullies for the several motions.

The motions to be given to the boring-bar are threefold.

1st. A very slow but extremely powerful movement; this is obtained by means of a worm on the shaft, *b*, which works in a box of oil, and is placed under the worm-wheel, *c*; this is the boring medium. A change of the rate of boring is secured by the cone pullies, and also, if necessary, by changing the spur gear, *d*.

2nd. A quick motion to run the boring-bar out of the bore; and,

3rd. A similar motion to run it back again to prepare for boring.

These two movements are secured by the ordinary three-pulley and three-bevel wheel arrangement, similar in action to the gear of Mr. Whitworth's planing machine; both the worm-wheel and the bevel-wheel are provided with a socket and clutch, which runs loosely on the shaft, *e*; and placed between them is a double clutch, sliding on feathers.

The various movements to be given to this double clutch, as also the shifting of the three-pulley strap, are effected from that part of the lathe where the workman may be supposed to be generally stationed, namely, at the muzzle of the gun; the arrangements being such that the handles are always in the same position with regard to the muzzle, whatever the length of the gun. The two spindles, *g* and *h*, are hollow, and are fitted with the requisite handles at their extremities next to the gun; into these hollow tubes are fitted the two shafts, *i* and *j*, both having a groove through their entire length, these grooves corresponding with feathers in the end of the tubes; so that as the boring apparatus is shifted to suit guns of different lengths, the shafts draw out or in, and are right in any position.

It will be seen by reference to the Plate, that the boring-bar, K, is a round parallel rod, accurately turned, so as to work freely through the bearing on C, while the other end is held fast in a couple of bearings on the boring-saddle, F, which are pinched sufficiently for the work required, by means of a lever on the screw handles.

By having round bearings throughout, the axes of the main spindle of the gun and of the boring-bar, are got into and kept in a line without any difficulty.

The saddle, F, which carries the end of the boring-bar, K, is actuated by a long screw placed within the bed, D (but which is not seen in any of the figures); and an arrangement is also provided for working this screw by hand with the lever, *m*, and rachet-wheel, *n*, during the operation of finishing the bottom of the bore.

These lathes are so powerful that they will bore from the solid a hole 12 in. in diameter.

AN INQUIRY INTO THE STRENGTH OF BEAMS AND GIRDERS OF ALL DESCRIPTIONS, FROM THE MOST SIMPLE AND ELEMENTARY FORMS, UP TO THE COMPLEX ARRANGEMENTS WHICH OBTAIN IN GIRDER BRIDGES OF WROUGHT AND CAST IRON.

By SAMUEL HUGHES, C.E., F.G.S., &c.

(Continued from page 271., Vol. xv.)

STRAIN ON GIRDERS CAUSED BY LOADS ACTING TRANSVERSELY.

THIS is a term very commonly made use of, and though not usually computed on very strictly mathematical principles, it yet furnishes a ready method of comparing girders with each other. The following expla-

* Plate cxvi., containing these other views, will appear in our next Number.

nation, showing what is meant by the strain on a girder, will render tolerably clear the simple method of calculating the strain, as commonly practised:—

When a beam is loaded by a weight pressing from above, or suspended from it, the top part of the beam is acted on by a force or strain of compression, and the bottom part by a tensile strain or strain of tension.

It is usual to calculate the amount of these strains per square inch of section, both for the top and bottom flange: thus, if S be the whole strain in tons, a the area of the top flange, and a' the area of the bottom flange, both in inches, then

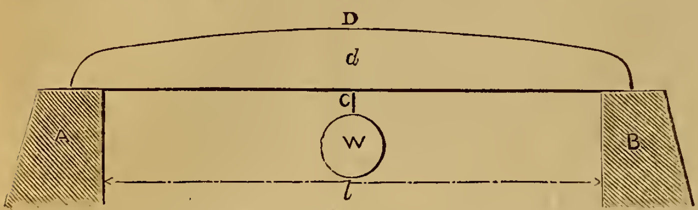
$\frac{S}{a}$ = strain of compression, in tons per square inch, and

$\frac{S}{a'}$ = strain of extension, in tons per square inch.

The amount of the whole strain on a girder, or the value of S, is thus found.

Let W be the whole maximum load that can act on the centre of the girder, plus half the weight of the girder itself.

l = length of the girder in inches between supports, or clear span of the bridge; also, d = depth of the girder in inches in the centre.



When a beam is loaded with any weight in the centre, the weight on each support is, of course, $= \frac{W}{2}$; but, in order to find the strain at the centre of the beam, as at C and D, we must consider the weight W as acting at the end of the bent lever, A C D; and hence, the strain at D and C is increased in the ratio of C D to A C, or as $d : \frac{l}{2}$; and, as $\frac{W}{2}$ is the weight acting on A, we have the strain on C and D by this proportion $d : \frac{l}{2} :: \frac{W}{2} : S$, the strain required; or, in other words, $S = \frac{l}{2} \times \frac{W}{2} \div d = \frac{l\,W}{4\,d}$.

In any beam where a is the area of the top or bottom flange in square inches, the strain per square inch is, of course, $\frac{l\,W}{4\,a\,d}$; and, where the weight is acting downward, the strain is one of compression on the top flange, and is a tensile strain or one of extension on the bottom flange.

In the construction of a beam it is of course useless to strengthen one part and leave another weak; other circumstances being alike, a chain supporting a weight will break, if at all, at the weakest link; and if one be weak, it matters not how strong are the others. So with a beam, if either the strain of compression or extension be more than the section will sustain, the beam will give way, unless the resisting force be made disproportionately strong, in order to counteract this weakness. It is, therefore, the practice so to arrange the material in beams,—in other words, so to apportion the top and bottom flanges that, theoretically, each will be equally strong, and if broken at all, each will give way at the same moment. Thus, experiments having shown that cast iron resists compression with about six times the force with which it resists extension, the theoretical cast-iron beam, based on this consideration, has its bottom flange six times the area of the top. Again, it has been found that wrought iron is more easily compressed than extended—that it resists extension better than compression in the ratio of 6 to 5; and owing to this property in wrought iron, it has been usual to make wrought-iron beams with the bottom flange one-sixth less in area than the top flange, while, in tubular structures, the same rule is followed of making the bottom part of the tube bear the same ratio to the top. In some tubular girders the bottom part has been made with only half the area of the top.

We have seen that $S = \frac{l\,W}{4\,d}$, where l is in inches; from which it follows, where l is in feet, that $S = \frac{3\,l\,W}{d}$; or, in words, the strain both of compression and extension in the centre of the girder, is equal to the weight in the centre multiplied by three times the length in feet, divided by the depth.

Example.—Required the strain on one of the four girders of a bridge on the Great Northern Railway, in which the span is $44\frac{1}{4}$ ft., depth d = 45 in., the area of top flange $17\frac{1}{2}$ in., area of bottom flange 60 in.

Assume a rolling load of 2 tons per foot for a single line, including the weight of the girders and platform, then the distributed load = $88\frac{1}{2}$ tons

The load on one girder .... = $44\frac{1}{4}$ „

The load in the centre, or value of W .... = 22·125 „

Hence, $\frac{3 \times 44{\cdot}25 \times 22{\cdot}125}{45} = 65{\cdot}7$ tons.

So that compressive strain $= \frac{65{\cdot}7}{17{\cdot}5} = 3{\cdot}75$ tons per square inch, and

tensile strain $= \frac{65{\cdot}7}{60} = 1{\cdot}09$ tons per square inch.

Now, the force required to compress or crush cast iron is seldom less than 40 tons per square inch, so that the strain is less than ten times the actual strength.

Again, the ultimate tensile strength of cast iron, according to Mr. Hodgkinson's experiments, is never less than 6 tons per square inch; so that the strain here is less than five times the actual strength.

If W′ be the weight distributed, and l' be the length in terms of the depth or value of $\frac{l}{d}$, then we have $S = \frac{W'l'}{8}$, or if W be the weight in the centre, $S = \frac{W\,l'}{4}$.

We have seen that where l is in feet the value of S is $\frac{3\,W\,l}{d}$, and the strain per square inch of section is $S = \frac{3\,W\,l}{A\,d}$.

We have also seen that the breaking weight W is $= \frac{n\,A\,d}{l}$. Hence, $n = \frac{W\,l}{A\,d}$, or one-third of the strain, so that the strain per square inch, when the breaking weight is applied, is merely three times the value of the constant for breaking weight.

In the Hodgkinson beam the strength has been roughly computed from the power of the bottom flange to resist a tensile strain. Thus cast iron will bear a tensile strain of about $6\frac{1}{2}$ tons per square inch; hence, $\frac{6{\cdot}5}{3} = 2{\cdot}167$ tons, the value of n, in the form $W = \frac{n\,a\,d}{2}$, where a is the area of the bottom flange.

This calculation supposes no strength derived from the resistance either of the top flange or middle rib, these being merely confined to the office of keeping the beam stiff and rigid, while the bottom flange is resisting the tensile strain brought on it by the weight.

Where l represents the length in inches, $S = \frac{W\,l}{4}$; in which case the value of n for a length in inches is four times the tensile strain, or $6{\cdot}5 \times 4 = 26$, which is the coefficient proposed by Mr. Hodgkinson for a length in inches, and corresponds, as we have seen, with 2·167 for a length in feet.

Mr. Clark shows how a very simple expression for the strain may be derived in all girders which have the length about sixteeen times the depth, a common proportion, both in tubes and ordinary girders. Taking l' in inches, we have $S = \frac{W\,l'}{8}$, and if $l' = 16$, $S = 2$ W, or simply twice the weight. If l be in feet, $\frac{l}{d} = 1{\cdot}3\dot{3}$, and as $S = \frac{1{\cdot}5\,W\,l}{d}$, if we substitute $1{\cdot}3\dot{3}$ for $\frac{l}{d}$, we have $S = 1{\cdot}5 \times 1{\cdot}3\dot{3}\ W = 2\ W$, or equal to twice the weight as before.

If a beam be fixed at one end, and loaded at the other, the strain at the fixed end is double the strain in the centre of a beam supported at both ends; hence, where l is in inches, $S = \frac{W\,l}{2\,d}$; or, if W′ be the weight distributed, $S = \frac{W'\,l}{4\,d}$; where l is in feet $S = \frac{6\,W\,l}{d} = \frac{3\,W'\,l}{d}$.

It has been asserted by some writers on mechanics, that an arch may be considered as a beam, whose depth is equal to the versed sine, and that a chain bridge in the same way may be considered as a beam, whose depth is the versed sine of the chain, measured from the level of the line of suspension to the lowest level of the curve. Hence, if l be the span of an arch or suspension bridge, d the depth or versed sine, both in feet, a the area in square inches at the key stone, or the area of the suspension chains, then $S = \frac{3\,W\,l}{d}$, and the strain per square inch $= \frac{3\,W\,l}{a\,d}$.

The following table is a compendium of the preceding formulæ, show-

ing in a simple form the value of the strain in the cases which most commonly occur in practice :

TABLE, *shewing the Strain in Tons on Girders, Arches, and Suspension Bridges.*

	W = weight on the centre in tons.		W = weight in tons distributed.	
	Value of S, or total strain.	Value of strain per square inch of section.	Value of S, or total strain.	Value of strain per square inch of section.
Where l = length in feet.......	$\frac{3\,W\,l}{d}$	$\frac{3\,W\,l}{a\,d}$	$\frac{1{\cdot}5\,W\,l}{d}$	$\frac{1{\cdot}5\,W\,l}{a\,d}$
Where l = length in inches....	$\frac{W\,l}{4}$	$\frac{W\,l}{4\,a}$	$\frac{W\,l}{8}$	$\frac{W\,l}{8\,a}$
Where $l = 16\,d$	4 W	$\frac{4\,W}{a}$	2 W	$\frac{2\,W}{a}$

GENERAL SUMMARY OF RESULTS ON THE TRANSVERSE STRENGTH OF WROUGHT AND CAST IRON.

Whilst writing the earlier articles on this subject, and endeavouring to show that the coefficient for transverse strength should in all cases be applied to the whole area of the beam, whether of wrought or cast iron, and whatever its form, whether rectangular, flanged, or tubular, I had not attentively examined Mr. Edwin Clark's valuable work on the "Britannia and Conway Bridges," in which are many experiments and formulæ relating to the strength of beams. I have since had the pleasure of observing that Mr. Clark takes the same view which I have already so often expressed relative to applying the coefficient in all cases to the whole area of the beam, instead of applying it to a small part of this area only.

When the coefficient is applied to the whole area, it gives a direct method of comparing the weight of material in beams of different forms or different metal; whereas, if the coefficient be applied to a flange, which is sometimes two-thirds of the whole area, and sometimes less than one-fourth, it is obvious this is productive of great confusion, unless the proportion of flange to whole area be always known and borne in mind. Unquestionably the most useful form of coefficient is that which applies in all cases to the whole area.

The following values of n in the equation $W = \frac{n\,A\,d}{l}$, are taken from Mr. Clark's book, with this simple alteration, that I have adjusted the values which he gives for a length of inches to those corresponding with a length in feet. The reason of this is obvious, as the values thus correspond with those which have been used throughout these articles.

Wrought Iron

	Value of n in Tons.
Rectangular tubes with thick top and bottom plates and thin sides, as in the large model of Britannia and Conway Bridge, or in the tubular bridges themselves	2·225
Wrought-iron welded tubes without rivets.	
Rectangular tubes of uniform thickness	1·958
Elliptical tubes of uniform thickness	1·858
Circular tubes of uniform thickness	1·742
Round rivetted tubes	1·086
Oval rivetted tubes	1·275
Rectangular rivetted tubes	1·506
New round bars	·750*
New rectangular bars	1·275
Rectangular bars previously strained	1·858
Cast Iron.	
Uniform rectangular tubes	·913
Uniform elliptical tubes	1·008
Uniform circular tubes	·952
Uniform square tubes	1·139
Small rectangular bars	1·133†
Large rectangular bars	·750†
Round bars, small	·667
Miscellaneous.	
Rectangular beams of deal	·121

* I can find no experiments producing so small a coefficient as this for wrought-iron bars: the page to which Mr. Clark refers for the experiments, contains nothing on the subject.

† These are from experiments by Mr. Robert Stephenson.

Coefficients of various Authors and Experimenters already quoted in THE ARTIZAN.

Wrought Iron.

	Value of n in Tons.	Page.
Drewry for rectangular bars	1·428	217
Lillie for rectangular bars	1·275	218
Fairbairn for flanged beams	1·240	218
Fairbairn for plate beams	1·727	219
Fairbairn for rectangular tube (model of Britannia tube)	1·710	220

Experiments on Cast-iron Bars by various Authorities, transferred for comparison from page 171 *of* THE ARTIZAN.

	Value of n in Tons.
Fairbairn's strongest cold blast	1·167
Fairbairn's weakest cast iron	·717
Fairbairn's best anthracite	1·044
Fairbairn's worst anthracite	·787
Reynolds	1·013
Tredgold	1·137
Templeton	1·151
Rennie	1·163
Beardmore	1·191
Banks	1·300
Trotter	1·459
Humber	·760
Barlow	1·130

Experiments by Hodgkinson and Fairbairn on Flanged Cast-iron Beams, transferred for comparison from p. 174 *of* THE ARTIZAN.

Beam with equal flanges.	·928
Beam with only bottom flange	1·131
Hodgkinson Beams.	
Flanges as 1 to 2	1·006
" 1 to 4	1·072
" 1 to 4	1·269
" 1 to 4½	1·247
" 1 to 5½	1·312
" 1 to 6	1·597
" 1 to 6·73	1·402
" 1 to 6·72	1·522
Fairbairn's selected or average experiment	1·498

Before proceeding to consider the various other forms of iron bridges, it will be necessary to examine more particularly both the crushing and the tensile strength of iron.

The following table, showing the result of experiments by Mr. Eaton Hodgkinson, on the relative tensile and crushing strength of cast iron, is a valuable contribution to our knowledge on this subject:—

Hodgkinson's Experiments, made for Railway Commission in 1849, *on the Comparative Tensile and Crushing Strength of Cast Iron.*

DESCRIPTION OF IRON.	Mean specific gravity.	No. of experiments on tensile strength.	Tensile strength in tons per square inch.	No. of experiments on crushing strength.	Crushing weight in tons per square inch.	Mean ratio of power to resist tension and compression.
Low Moor, No. 1	7·074	5	5·667	6	27·003	1 : 4·756
Low Moor, No. 2	7·043	3	6·901	5	42·824	1 : 6·205
Clyde, No. 1	7·051	3	7·198	6	40·537	1 : 5·631
Do. No. 2	7·093	3	7·949	6	47·326	1 : 5·953
Do. No. 3	7·101	3	10·477	6	47·338	1 : 4·518
Blaenavon, No. 1	7·042	3	6·222	4	38·263	1 : 6·149
Do. No. 2	7·113	3	7·466	4	49·109	1 : 6·577
Do. No. 2	7·051	3	6·380	6	30·600	1 : 4·796
Calder, No. 1	7·025	3	6·131	4	33·075	1 : 5·394
Coltness, No. 3	7·024	2	6·820	4	45·091	1 : 6·611
Brymbo, No. 1	7·071	3	6·410	5	33·591	1 : 5·216
Do. No. 3	7·037	3	6·923	5	34·172	1 : 4·936
Bowling, No. 2	6·989	3	6·032	5	33·507	1 : 5·555
Ystalyfera Anthracite, No. 2 ..	7·119	5	6·478	5	43·635	1 : 6·735
Ynyscedwyn Anthracite, No. 1 ..	7·034	3	6·228	5	36·198	1 : 5·811
Ynyscedwyn Anthracite, No 2 ..	7·013	3	5·959	5	34·038	1 : 5·712
Morries Stirling, 2nd quality ..	7·165	5	11·502	6	54·640	1 : 4·751
Do. do. 3rd quality ..	7·108	3	10·474	6	64·403	1 : 6·149

Mr. Hodgkinson had previously determined, in experiments on eleven different kinds of cast iron, that the mean ratio of the tensile to the crushing forces was 1 : 6·595.

The mean ratio of the same forces in the above Table, is 1 : 6603. In deriving this mean, Mr. Morries Stirling's iron is omitted, it being a compound one.

The Modulus of Elasticity.

This is the quotient arising from dividing any weight W in lbs. by the extension in inches of a bar of iron 1 in. square and 1 in. long, when the weight W is suspended from it.

Thus $\frac{W}{e} = M$, and $\frac{W}{M} = e$.

Hence, if l be any length in inches, W any weight in lbs., and a any area in inches, we have $\frac{A\, l\, a}{M} = e$, the extension in inches. The value of M for cast iron varies from 14,000,000 to 18,000,000, and for wrought iron is about 28,000,000, or nearly double.

From the equation $\frac{W\, l\, a}{M} = e$, we find where e is 1 in. $W\, l\, a = M$, and if l and a be also 1 in. $W = M$. Hence the modulus of elasticity may be defined as the weight which will extend a piece of iron an inch square to double its length.

The preceding explanation will show that the modulus of elasticity is not the same as tensile strength, with which it has been sometimes confounded. Some modern writers scarcely make use of the term modulus of elasticity; and it is probable it will go entirely out of use as we get more correct expressions for the tensile and compressive strength of iron.

At p. 173 of The Artizan will be found the modulus of elasticity or value of M in the equation $\frac{W\, l\, a}{M} = e$, as determined by Mr. Hodgkinson for several different kinds of cast iron.

It was found, however, in subsequent experiments, that cast iron, when acted on as by a tensile force, did not follow the same law of proportionate extension as wrought iron.

Compression and Extension of Cast Iron.

The Commissioners of 1849 caused very accurate experiments to be made on this subject. The extensions were determined by attaching a bar 50 ft. in length and 1 in. square to the roof of a lofty building, and suspending weights to its lower extremity.

The compressions were ascertained by enclosing a bar 10 ft. long and 1 in. square, in a groove placed in a cast-iron frame, which allowed the bar to slide freely without friction, and yet permitted no lateral flexure. The bar was then compressed by means of a lever loaded with various weights, and every possible precaution was taken to procure accuracy. The following formulæ were deduced for expressing the relation between the extension and compression of a bar of cast iron 10 ft. long and 1 in. square, and the weights producing them respectively:

$$\text{Extension } w = 116117\, e - 201905\, e^2 \ldots (33)$$

$$\text{Compression } w = 107763\, d - 36318\, d^2 \ldots (34)$$

where w is the weight in lbs. acting on the bar, e the extension, and d the compression in inches.

And the formulæ deduced from these for a bar 1 in. square and of any length are,—

$$\text{For extension } w = 13934040\, \frac{e}{l} - 2907432000\, \frac{e^2}{l^2} \ldots (35)$$

$$\text{For compression } w = 12931560\, \frac{d}{l} - 522979200\, \frac{d^2}{l^2} \ldots (36)$$

where l is the length of the bar in inches.

These formulæ were obtained from the mean results of experiments on four kinds of cast iron.

Equations 33 to 36 take the form of quadratics, and may be solved for the value of e. Thus, for bars 10 ft. long, and 1 in. square, we derive from equation 33—

$$e = \cdot287554 - \sqrt{\cdot082687 - \frac{w}{201905}} \ldots\ldots (37).$$

Also, for a bar or rod of any length, and 1 in. square, we derive from equation 35—

$$e' = \cdot0023961\, l - \sqrt{\cdot00000574\, l^2 - \frac{w\, l^2}{2907432000}} \ldots\ldots (38).$$

For the compression of a bar 10 ft. long, and 1 in. square, we derive from equation 34—

$$d = 1\cdot483603 - \sqrt{2\cdot201078 - \frac{w}{36318}} \ldots\ldots (39).$$

And for the compression of a bar of any length, and 1 in. square, we derive from equation 36—

$$d' = \cdot012363\, l - \sqrt{\cdot0001529\, l^2 - \frac{w\, l^2}{522979200}} \ldots\ldots (40).$$

Examples, showing the Use of the preceding Formulæ.

Example 1.—What weight will extend a bar of cast iron 4 in. in area, and 10 ft. long, to the extent of $\frac{1}{600}$th of its length. Here $e = \frac{120}{600} = \cdot2$ in.; and by equation 33, $w = 116117 \times \cdot2 - 201905 \times \cdot2^2 = 23223\cdot4 - 8076\cdot2 = 15147\cdot2$ lbs., the weight which will thus stretch a bar 1 in. square. Hence a bar 4 in. square will require $15147\cdot2 \times 4 = 60589$ lbs. to stretch it one-fifth of an inch.

Example 2.—Let us now reverse the case, and inquire what extension will be produced by a weight of 15,147 lbs. suspended from a bar of cast iron 10 feet long and 1 in. square. Here, by equation 37, we have—

$$e\ \ \cdot287554 - \sqrt{\cdot082687 - \frac{15147}{201905}} = \cdot287554 - \sqrt{\cdot0076} = \cdot2,$$ or one-fifth of an inch.

Example 3.—Required the weight which will produce an extension of $\frac{1}{4}$ in. in a bar of iron 1 in. square, and 25 ft. long. Here, by equation 35, we have $13934040 \times \frac{\cdot25}{300} = \ldots\ldots$ 11611·7

And $2907432000 \times \frac{\cdot0625}{90000} = \ldots\ldots$ 2019

The difference ...... 9592·7 lbs.

being the weight which will produce this extension.

Example 4.—To find the converse of this problem, or the extension produced by 9,593 lbs.

Here, by equation 38, we have ......$\cdot0023961 \times 300 = \ldots$ ·7188300

$\cdot00000574 \times 90000 = \cdot51660000$

$\frac{9593 \times 90000}{\cdot2907432000} = \frac{\cdot29694000}{\cdot21966}$ $\quad\sqrt{\cdot21966}$ .... ·4686811

Difference ...... ·2501489

the extension required, or value of e'.

Formulæ for Compression.

Example 5.—What weight will compress a bar 10 ft. long and 1 in. square to the extent of $\frac{3}{4}$ in. when acting on it in the direction of its square?

Here we have by equation 34—

$107763 \times \cdot75$ ...... 80822·25

and $36318 \times \cdot75^2$ ...... 20428·87

The difference...... 60393·38

is the weight in lbs. which will produce a compression of $\frac{3}{4}$ in.

Example 6.—Required the compression that will be produced on a 10-ft. bar 1 in. square, by a weight of 60,393 lbs.

By equation 39, we have ...... 1·483603

Less $\sqrt{2\cdot201078 - \frac{60393}{36318}}$ ...... ·733 and

The difference ...... ·750 is the compression required.

It is unnecessary to continue these examples any further, as the weight and compression for bars of any length can be readily ascertained from equations 36 and 40.

It will be observed that equations 33 and 34 apply to bars 10 ft., or 120 ins. in length. Now in the corresponding equations 35 and 36, for bars of any length, the coefficients of $\frac{e}{l}$ and $\frac{d}{l}$ are respectively 120 times the coefficients of e and d in equations 33 and 34; also, the coefficients of $\frac{e^2}{l^2}$ and $\frac{d^2}{l^2}$ are respectively equal to 14,400, or 120^2 times the coefficients of e^2 and d^2. Hence equations 35 and 36 must give corresponding results to 33 and 34. Again, in equations 37 and 39, the numbers ·287554 and 1·483603 are respectively 120 times the coefficients of l in equations 38 and 40. Also, in equations 37 and 39, the numbers ·082687 and 2·201078 are respectively 14,400 times the coefficients of l^2 in equations 38 and 40; and the same proportion holds between the denominator of w in equations 37 and 39, and the denominator $w\, l^2$ in equations 38 and 40.

It will be seen from examining the preceding formulæ, that no greater extension can be calculated than about $\frac{1}{500}$th of the length. For instance, in equation 38, when the extension exceeds ·0023, or a little more than $\frac{1}{500}$, the expression becomes negative; and as the quantities after the *minus* sign are all to be subtracted, the value of e' may be equal to, but can never exceed $\cdot0023961\, l$. In the same way the compression calculated by the formulæ may be equal to, but can never exceed $\cdot012363\, l$, or a little more than $\frac{1}{100}$th part of the length.

(*To be continued.*)

A FEW REMARKS ON BOILER EXPLOSIONS, AND THE CAUSES TO WHICH THEY ARE ATTRIBUTED.

By Edward Strong.

There is a mystery in connection with boiler explosions which engineers have not yet been able satisfactorily to solve. In reading evidence given in connection with the most of these accidents, we nearly always find allusions made to explosive gas being generated in the boilers by the decomposition of water, through the plates of the boilers having become heated from the water having been allowed to fall too low. Now, is not this theory too often made use of when there is really next to an impossibility for such to have been the case? I think to this more particular attention should be called; and, before this theory be allowed to bear on the particular case, it should be first proved that there was a possibility of the water having become decomposed, and also of the hydrogen gas thus liberated having become inflammable or explosive by an admixture of air or oxygen gas.

As an instance of this we will take—say the case of a locomotive boiler having burst; and where there is, as usual, a difficulty of tracing the true cause of accident, it is said, "the water may have been too low." The theory of decomposition of water is then brought forward, and it is allowed that the boiler has most probably burst from an explosion of hydrogen gas. Now, in this case, is there in reality any grounds for such a conclusion? "Iron heated to redness will decompose water;" but the fire-box and tubes of a locomotive boiler, which are the parts likely to become heated from want of water, are made—the fire-box of copper, and the tubes of brass. "Copper does not decompose water at any temperature," and the water in this case could not have become decomposed. The cause of explosion must therefore be attributed to some other cause—most likely weakness in construction of boiler, or some defect in the safety-valve or spring balance. Now, could it be made an established law that a locomotive boiler with copper fire-box and brass tubes will not decompose water when these parts are heated to redness from the water being too low, it would very much facilitate the investigations as to the causes of explosions, by bringing the inquiries within narrower limits. The strength of boilers and state of safety-valves would then command more attention. That locomotive boilers of this construction do not decompose water, I may state positively, as I have seen an engine-driver endeavouring to pump water into the boiler of the engine he was working when the top of the fire-box and top rows of the tubes had become heated to redness, from the water having previously been too low. There was no water in the tender tank (of this he was not aware); and such being the case, the pumps would be forcing air instead of water into the boiler. Now could anything have been more favourable to an explosion of hydrogen gas (had the water really become decomposed) than this? and yet no such accident took place: the copper of the fire-box was injured, and also the top rows of tubes, but nothing beyond this.

The heating of the top of the fire-box and top rows of tubes from shortness of water, is a more common occurrence than many imagine; and this occurs without any damage beyond injury to the metal of these parts. The result in most of these cases is, that one or more of the tubes in the top rows give way from weakness caused by over heat, and the fire is extinguished by the rush of steam from the burst tube. The means of preventing this undue heating of the fire-box from want of water is so simple that I cannot account for its having been so often neglected: I mean by the *proper use* of the fusible, or what is commonly termed, "lead plug." Many engineers say it is useless; but when is it so?—only when neglected, when any other mechanical contrivance would become the same. In too many cases the lead plug, put in when the engine is built, is left to remain for years, if it will do so: thus it is certainly useless, as a crust forms in time, which effectually prevents the lead from escaping when melted, and which crust the pressure of steam will not overcome; but where, as on well-managed railways, the lead plug is properly attended to, that is, renewed monthly, I can state from experience that I have never known it fail, and every dependence may be placed upon it.

The steam escaping from the orifice from which the lead has been melted may not, where the fire is very large, be sufficient to extinguish it; but it damps it, and gives the driver time and warning to draw the fire. I would recommend larger plugs being used—say 1in., which would thus extinguish the largest fire; and these being fitted as lead washers, secured by a nut, would be preferable to the form of a plug. My reason for giving so much importance to the proper use of the lead plug in connection with boiler explosions is, in the first place, that they would prevent effectually the heating of the fire-box and tubes from the water being allowed to fall too low, and thus prevent the possibility of hydrogen gas being generated, from which such serious results appear to follow; and, secondly, that, after an explosion has taken place, the lead plug being found *not melted*, would be positive proof that there had not been a scarcity of water. The use of the lead plug, and its being kept in proper working order, should be enforced. By proper working order, I mean its being renewed monthly, and also of its being of sufficient size.

I have confined my remarks at present to locomotive boilers fitted with copper fire-box and brass tubes: there are a few exceptions to this, a few being fitted with iron tubes—I may say, very few. With a boiler of this construction, the tubes having become heated to redness from the water being too low, hydrogen gas would be generated by the decomposition of the water from this cause; but, before attributing the bursting of a boiler to the explosion of the hydrogen gas thus present, there should be first a reasonable supposition that air was also present in the boiler. Now the greater number of these accidents occur when the engine is stationary, and when air could not be gaining admittance into the boiler. The only circumstances under which air could be forced in would be when the engine was working—either when the tender tank was empty, or by the feed-pipes being broken or disconnected; then air would be forced in. In investigating the cause of a boiler explosion, it should be considered as necessary to look for the possibility of the presence of air as for the possibility of the shortness of water. When the parts of a boiler are heated to redness, there is more danger to be apprehended from pumping in air than cold water: this does not seem to be generally known.

Copper being a metal which does not decompose water, I have classed the brass of which locomotive tubes are made, as the same, the proportion of zinc and tin being small. I think experience also proves this.

From the remarks I have made, I wish it to be thoroughly understood that I do not for a moment mean to assert that boilers may not have burst from an explosion of hydrogen gas. I simply have endeavoured to show that boiler explosions are in too many cases attributed to this cause, when there is really no grounds for such an opinion, and that it is thus often made an obstacle to further inquiries.

TUNNEL BORING MACHINERY.

(Illustrated by a Diagram of the Apparatus.

Invented by Messrs. Grattoni, Grandis, and Sommeiller, for boring the Mount Cenis Tunnel.)

Various mechanical arrangements have been invented of late for the expeditious boring of tunnel galleries. The occasion of the proposed piercing of the Alps, which divide Piedmont from France, offered an opportunity for the employment of such means. The chief difficulties attending this work are (besides the extent and importance of the undertaking referred to, which have called for the application of mechanical means) the impossibility of sinking shafts for beginning the excavation at several points, and the direction of the incline of the tunnel itself, which, offering on one side a natural exit to the natural springs (on the Savoy side), precludes the possibility of extracting them on the other side of the Alps, but by pumping.

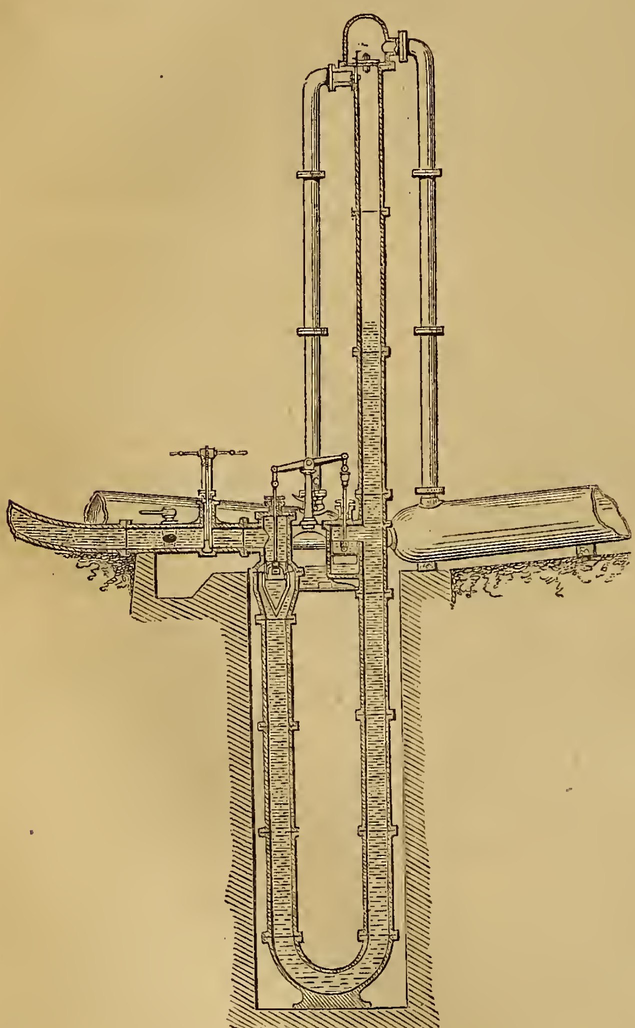
Mr. Maus, after three years of study, brought forward a new excavator, which, acting by percussion, separated the masses of rock into smaller fragments, with the help of wedges; and so, though working at a slower rate than by common blasting with powder, evaded the difficulty of the strong ventilation necessary to carry out the gasses arising from the explosions. This he put in motion by two water-wheels, which, through ropes and pulleys, work as in the inclined plane on the railway at Liege, constructed by the same inventor. This excavating machine was proved at Valdous, before the Government Commission, and was thought satisfactory; but it was afterwards objected to and rejected on account of the unsatisfactory transmission of movement, and the insufficiency of the ventilating means, which were to be in this case a number of fans.

After him, Mr. D. Colladon, Professor of Engineering in Genoa, obtained on the 30th June, 1855, a patent for a new method of excavating galleries. In his specification he says, "The chief mechanical means used or proposed heretofore for giving motion to tools at the bottom of a mine, are the application of cables, ropes, or chains acting either by a continuous, or an alternating motion; the use of steam acting directly; that of the vacuum by means of a suction-pipe, or that of a water-power engine. The new process proposed by me differs essentially from them, not only in its principle, but also, and above all, by a useful arrangement by which the chief desiderata, when mines are to be excavated, can be immediately obtained; that is, ventilating and regulating the temperature, making a reserve of motive power when the tools are stopped, and abridging the work of tools by new appliances."

The chief features of Mr. Colladon's invention consists in the use of compressed air for transmitting power to a boring or excavating machine in the gallery itself, the action of the engine or motor being outside. The air compressed by a water-wheel or steam-engine, or any other motor, and sent into the galleries by a pipe was to give motion to the excavating tools, as well as to the boring tools for blasting and such like purposes, and at the same time was to renew by a jet of fresh air that vitiated by respiration or the explosion of mines.

Upon the same day that Mr. Colladon took out his patent another was granted to Mr. Thomas Bartlett for a kind of locomotive engine and apparatus, with the adjunction of the tools proper for working the gallery. The piston-rod of the steam-cylinder has fixed to its head a second piston-rod and piston working in a second cylinder (in a line with the first), which may be called the pneumatic cylinder. In this one works a third piston, which has attached to its rod a mining tool. Between the two a certain quantity of air is compressed by the action of the first piston, and acting as a spring, drives with force the tool against the rock at the end of the motion, and at the return stroke a part of the compressed air escapes through a valve. The third piston is acted upon by the vacuum then obtained, and retrogrades; but at the end of the stroke a small opening gives again admission to a quantity of air equal to that which has escaped. All this is so rapid that the tool strikes 200 to 300 blows per minute.

GRATTONI & CO.'S TUNNEL BORING APPARATUS.



Messrs. Grattoni and Co.'s machine consists in the application of Mr. Colladon's invention to give the motion to Mr. Bartlett's excavator, as in long galleries the use of steam is not practicable. For this the invention of a new engine, at once simple and effective for compressing the air, was necessary, and this is effected by the application of water power.

A vertical pipe, several feet in diameter, say 50 or 60 ft. high, is connected at its foot with a short horizontal tube of the same diameter, which itself opens into the bottom of a cylindrical vessel in the shape of a hollow column closed at the top, say about 15 ft. high. A valve intercepts at will the communication between the vertical and the branch pipe. This forms, it will be seen, an inverted syphon; the longer branch opens on the top, the other being closed. This valve is called the feed valve.

When the operation begins, the column being full of air, the water descending through the vertical pipe, acts by its own weight, compresses the air, and if the area of the feed valve differs little with the section of the tube, the descent of the column of water becomes very rapid, and by its *force-viva*, or impetus, compresses the air contained in the air-vessel long after the moment when both the pressures of the water and the air have become equalised. The air-vessel not being entirely close, but with a large and light valve in communication with an air reservoir, the air by the reaction due to its elasticity, opens the exhaust valve and escapes before the motion of the column of water has ceased.

If besides, at the moment the action of the water is complete, an escape valve at the foot of the vertical pipe, and an admission pipe in the air-vessel open simultaneously, the water contained in the vertical column escapes and the air-vessel is filled again with air. The machine will have then finished a stroke, a blow, or rather a pulsation, and will be ready for the compression of a new volume of air. The motions of the feed and escape valves are self-acting. This is the hydro-pneumatic pressure engine for boring and tunneling designed by Messrs. Grattoni, Grandis, and Sommeiller. The air being compressed at a pressure of 100 lbs. or so to the square inch, they applied their motor or engine to driving Mr. Bartlett's excavator; a side elevation of which complete apparatus is shown in the accompanying illustrations.

The following is a Report of some official experiments recently made:—

The mechanical compresser was erected at the foot of the St. Benigno Pass, near San Pierdlaune, Genoa. It was fed by one of the mains of the water supply works of the town, the water of which was conducted into two reservoirs, at about 80 ft. above the level of the discharge-valve.

A third reservoir, about 165 ft. above the same valve, contains the water intended to maintain the pressure in the vessels or air-holders, so as to give motion to the water-power engine for effecting the self-acting motion of the valves. The pipes, vertical and horizontal, and the air-vessel were uniformly of 18 in. diameter.

The feed-valve was of the double beat Cornish description, and was constructed so as not to reduce in any manner the area of the tube, and so as to be worked without unnecessary loss of power.

The air-valve, which is of equal area with the tubes, divides the top of the compression-column from a bell or head, which receives at each blow the compressed air, and sends it to the reservoirs through a large copper pipe. These last consist of two chambers of boiler-plate, half an inch thick, and capable of containing each 150 cubic ft. These reservoirs, constructed like steam-boilers, communicate at the bottom with the water-pressure tank, from which they are filled before setting the apparatus in motion. When the machine works, at every blow or pulsation a certain volume of air passes from the compression-column into the air reservoirs, driving out an equal volume of water, which reascends into the tank. By this means the air in the reservoir is maintained at the pressure corresponding to the height of the tank, added to the atmospheric pressure. In this case, this height being 165 ft., the air pressure was equal to six atmospheres—or say 80 lbs. per square inch effective pressure. Three glass gauges, similar to those for steam boilers, indicated at each moment the level of the water in the air reservoirs, as well as the augmentations or diminutions of the volume of the compressed air.

It was found that the results of experiments gave—loss of air in the reservoirs 2 to 3 per cent. only.

The force necessary to reduce six litres to the volume of one litre, so as to compress it at six atmospheres, was measured at 59·37 kgm. for the compression itself, and 51·63 kgm. for sending it up to the reservoirs, in all 111 kgm. which is the power it can exert or give up in returning to its former volume.

The useful effect of the machine was calculated thus:—In 35 blows of the engines 2,682·86 litres of compressed air were obtained with a volume of 23,478 litres of water descending 23·95 metres, and 237·5 descending 51·5 metres, equal to 562,298 kgm., when the useful effect of the machine was 297,764 kgm. This is equal to a duty of 53 per cent.

The modifications to Bartlett's perforator, as invented by Messrs. Grattoni, Grandis, and Sommeiller, are:—1st. The new machine has one cylinder only, there being between the end of the cylinder and the only piston two cushions of compressed air in communication with the air-vessels. 2nd. The distribution of air is independent of the piston, and effected by one or two cylinders with self-acting mechanism. 3rd. The diameter of the piston, as well as the dimensions of the fly-wheel, and other parts, are much reduced. 4th. A self-acting forward motion is given to the machine as the work proceeds; and this is regulated according to the hardness of the rock to be perforated. 5th. The machine can easily be disposed to work in inclined positions, as necessary for blasting in the best direction.

THE UNITED STATES MAIL STEAMER "ADRIATIC."

The arrival of this long-looked for steamer, which was expected by our American cousins to "lick all creation," was announced on Thursday, the 3rd December, after a run of 10 days 21 hours, from New York, where she left 23rd November, 12·30 p.m.; and although this performance would be a great disappointment to the zealous advocates for the superiority of American naval architecture, yet it is due to the commander and owners to state that, in consequence of a slight fog and strong westerly gale blowing during the night, Captain West considered it advisable to lay off Point Lynas, to which point he ran in 10 days 4 hours, which would give for this her entire voyage, 10 days 8 hours mean time; a performance that has been repeatedly excelled upon the first voyages of both Cunard and Collins' steamers.

We do not, however, attach much importance to the speed falling so considerably short of the expectations of her designer upon this occasion, as, notwithstanding the repeated trials of her steam machinery, the alterations which have from time to time been made in connection therewith, and also the series of delays which have occurred in consequence thereof, the engines had not a fair chance of performing efficiently; and, moreover, Captain West is known to be an exceedingly careful navigator, and a judicious commander; and it is to be hoped that upon the next voyage to Liverpool the Sickel's cut-off apparatus will have been satisfactorily arranged and connected, and the engines and machinery thus have the opportunity of performing in accordance with the desire of the owners.

In The Artizan for September, 1856, page 212, will be found the principal dimensions, &c., of the ship and engines; and, on reference to The Artizan of February, 1855, page 32, a description of Pirsson's Surface Condenser will be found.

It will be remembered that the *Adriatic* and the *Niagara*, United States steam frigates, were designed by the late Mr. George Steers. The *Adriatic* was launched on the 7th of April, 1856, and has been fitted with engines by Stillman, Allen and Co., of the Novelty Iron Works, New York. The extraordinary delay which has occurred in completing this vessel for sea has, it is said, arisen entirely from the difficulties which have been found in adapting Sickel's cut-off apparatus to these large oscillating engines; and certainly, if we may judge by the disfigurement of the engines, framing, and engine-room arrangements, by these alterations, this would appear to have been the case.

It has been erroneously stated that the diameter of each of the oscillating cylinders is 100 in., whereas they are 1 in. larger; and the following dimensions and particulars, which we collected when visiting the ship at her moorings, on Tuesday, the 8th December, will doubtless prove of interest:—

The engines consist of two oscillating cylinders, each 101 in. in diameter; stroke, 12 ft.; the weight of each, with top and bottom cover, 101,324 lbs.; they are fitted with brass pistons, 12 in. deep, with cast-iron packing rings, 6 in. deep, and weigh 11,015 lbs. each; the piston-rods are 14 in. diameter, and weigh 17,118 lbs.; the main shafts are $26\frac{1}{2}$ in. diameter, and 35 ft. 6 in. long, weigh 64,550 lbs.; the two air-pumps 42 in. diameter, 5 ft. stroke; and condensed water-pumps, each 30 in. diameter, with 5 ft. stroke. There is a direct-acting horizontal donkey engine and feed-pump; the steam cylinder is 16 in. diameter, and the pump $8\frac{1}{2}$ in. diameter, and 12 in. stroke. The donkey engine is worked from a boiler which is exclusively used for giving it steam. There are eight boilers, of Martin's vertical tubular construction, with six furnaces in each; the dimensions of each boiler are 20 ft. $1\frac{1}{2}$ in. long, by 11 ft. 3 in. wide by 14 ft. high. The fire-grates are each 8 ft. long × 33 in. wide. The number of iron tubes in each boiler we could not ascertain; but their diameter is 2 in. inside, and about $\frac{1}{8}$ in. thick; they are fixed without ferrules, the thickness of the iron tube plates being at the top $\frac{3}{8}$ in., the bottom plate rather thicker. The shell of the boiler $\frac{3}{8}$ in. iron, and are fully stayed. The weight of the eight boilers, without water, is estimated at 710,074 lbs.; and, according to the measurements given by the chief engineer, the total heating surface should measure 30,000 square feet. The boilers were tested at 50 lbs. to the square inch. The working pressure is calculated at 25 lbs., and the consumption of coals on trial shows about 90 to 95 tons per day of twenty-four hours.

There are two of Pirsson's surface condensers (vacuum), a modification of those described in The Artizan, February, 1855. We were informed that the surface in each was equal to 12,000 sq. ft.; and the number of brass tubes (tinned inside and out), is 5,000, their diameter inside $\frac{3}{4}$ in. bare, and the thickness about No. 17 iron wire gauge.

The smoke from the eight boilers is conveyed by two funnels, each 40 ft. high by 7 ft. diameter, one fore and the other aft of the engines.

The paddle-wheels are each 40 ft. diameter, the floats each 12 ft. long, 24 in. deep.

It has been stated in some of the English newspaper reports that on the voyage here, the consumption of coal being greater than was anticipated, they ran short of fuel; this was not a fact, as the quantity of coal taken on board was stated by the vendor's account to be 1,368 tons of Pennsylvanian Anthracite, and at the time of her being moored at the Collins' buoy, above the Rock Ferry, she had 250 tons of coal in her bunkers.

Amongst the disadvantages under which the ship laboured was that the boilers primed very much, and the coals were not perfectly suited for the most economical combustion in the boiler furnaces; but when the priming has been checked, and every part of the machinery in good working order, it is expected that with easy firing, amply sufficient steam will be got to ensure a working pressure throughout the voyage at 23 to 25 lbs. per square inch, the steam being cut off in the cylinders at $\frac{1}{3}$ of the stroke.

With reference to the vessel, we have already stated she was designed by the late Mr. George Steers, and has some of the peculiarities of the *Niagara* U.S. Frigate, and like all the Collins' steamers, has an upright stem, or straight cut-water, and without a bowsprit; her lines are considered good; her draft was 22 ft. when we saw her, and we believe she was on about an even keel; and on referring to the particulars given in The Artizan for September, 1856, we find that her displacement at the 21 ft. 6 in. water-line was given at 5,800 tons, and the average displacement per inch between 17 ft. $1\frac{1}{2}$ in. light load line and 20 ft. draft, was $28\frac{3}{4}$ tons (per inch). She has two masts, the foremost only being square rigged; she is not too heavily masted or rigged, and is certainly, when under steam and sail, a very "ship-shape craft;" and we hope that before we go to press with The Artizan for February, we shall be able to report the second arrival of this splendid ship in the Mersey, after a much more rapid voyage than that we have just recorded. Until then we take leave of the subject, and defer the publication of a number of details which we have prepared relative to the arrangements and internal fittings of the ship, which are on a scale of magnificence and completeness quite unequalled by any ship in this country.

We had well nigh omitted to state that Silver's Patent Marine Governor is applied to the engines of the *Adriatic*; and Captain West speaks in the highest terms of the invention, and expressed his surprise that the Government and steam-ship owners in this country should be so blind to their own interest as not to insist upon marine-engine builders fitting governors on board every sea-going steamer.

THE YACHT "FANTASIE."

On Thursday, the 17th Dec., a beautiful yacht was launched from the yard of the Thames Iron Works, Blackwall. This vessel is 180 ft. long, 18 ft. beam, and 6 ft. draft; to be fitted with paddle-wheel engines of 120 H.P. She has been constructed under the directions of Messrs. George Rennie and Sons, the engineers, for the use of the Imperial Family of Austria. Several distinguished gentlemen from the Austrian Government were present at the launch, and were much pleased with the appearance of the vessel. When the trial trip of this vessel is made, we hope to give more details of her performance.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section G.

ON FUSED WROUGHT IRON.

By E. Riley, Esq., Dowlais Ironworks.

The fusibility of wrought iron and its properties is a subject upon which little has been written: some even doubting its fusibility. The following experiments were made to determine its properties:—

First,—Black plate from tin works was cut in pieces about three-eighths of an inch square, covered with the cinder from an old iron assay, placed in a wind furnace with a strong draught for two hours. The iron was perfectly fused, and formed a smooth even button (weighing 1,638 grains) under the cinder, which was of a dark green color. On attempting to cut it with a cold chisel it broke, with a very crystalline fracture, in the direction of the planes of cleavage of the crystals. The pot was taken out hot, and allowed to cool on an iron plate. Half of the button was worked out by a smith into a bar $\frac{1}{4}$-inch square. The iron was very soft, and had a fine face and sharp even edges like steel; two pieces were welded together;—whilst at a welding heat the iron worked very well; on cooling to a red heat it became very cracky, and broke; the fracture of the iron not exposed to a welding heat was very silky, and it was readily bent back double without cracking—the smith stating it was some of the toughest iron he ever worked. This experiment was repeated, and another, with 7 oz. of black plate, part of which ran out of the pot; the properties and character of the iron were precisely similar to those above detailed. In the second experiment shale and lime were used to form a cinder.

An experiment with the best $\frac{9}{16}$-inch cable-bolt (very fibrous). This bolt was cut in small pieces whilst hot, varying from $\frac{1}{4}$-inch to $\frac{1}{2}$-inch long; and 8 oz. of bolt, 5 gr. red ore, 300 gr. lime, and 260 gr. mine shale, were placed in a pot. In two to three hours the fire burnt down, the pot was taken out hot, and cooled on an iron plate; the iron was perfectly fused, and covered with a dark green cinder, the button being very smooth, and free from cavities; on trying to break it with a blunt tool, the button being laid hollow, it broke in several directions, all being planes of cleavage of the crystals, which extended through

the button, and had the appearance of galena. The properties of this iron were precisely similar to the fused black plate—viz., very tough and fibrous when worked cold, in this respect working very similar to copper. The smith, after having welded two pieces together, could not work it after it had cooled to a red heat, as it invariably cracked, and broke to pieces.

Six ounces of the same cable-bolt were fused *per se.* The iron ran down into a flattish button, with some olive cinder at the sides; the button broke with a crystalline fracture, the crystals not however so large as in the last experiment. It worked precisely similar to the previous button, and was useless after it had been exposed to a welding heat.

Half a pound of the same bolt was fused *per se* into a flattish button, the fusion being quite perfect; it broke with a very crystalline fracture, and proved in every respect similar to the last button.

Experiments were also made with ¾-lb. and 1 lb. of the same bolt, the iron running through the pots on the bars. On testing the burnt iron taken from the bars the properties were found to be the same as in the previous experiments. Did not succeed in obtaining a button more than ½-lb. weight, owing, probably, to the pressure of the melted iron against the soft sides of the pot. The pots used in these experiments were of Cornish clay, about 3 inches high, clay-lids being luted on.

Fused Wrought Iron made direct from the Ore.—Experiment No. 1, with calcined Welsh mine, the following proportions were used :—

Mine	2500	
Lime	450	
Anthracite	360	
		3,310

Weight of button, 1,241 grains. The cinder was dark green, and the button quite solid; it worked exceedingly tough and soft, like lead; on putting heat on the iron it cracked and broke like copper, and would not, in fact, take a higher temperature. This button was found on examination to contain no silicium, and ·29 per cent. of phosphorus. The following is an analysis of the calcined mine used :—

Silica	8·38	
Alumina	5·79	
Peroxide of iron	76·61	
Oxide of manganese	1·21	
Lime	3·13	
Magnesia	3·96	
Phosphoric acid	0·57	
Potash	0·87	
Sulphur	0·06	
		100·58

Experiment No. 2, on

Mine	2,500	
Lime	460	
Anthracite	375	
		3,335

Weight of button, 1,311 grains. The cinder was a little lighter in colour than the last; the button had a small cavity in the centre; a piece drawn out would not stand a welding heat, but crumbled to pieces like copper.

Experiment No. 3, on

Mine	2,500	
Lime	460	
Anthracite	390	
		3,350

Weight of button, 1333·5 grains. Cinder, olive green, not very dark, with a few black wavy lines. The button broke like cast steel, one half of it was found to stand no heat, the other portion worked into a small chisel, hardened on chilling, and broke with a tolerably close fracture.

Experiment No. 4, with red ore from Lynmouth Cornham Ford lode.

Silica	1·01	
Peroxide of iron	98·41	
Alumina	(traces)	
Peroxide of manganese	0·29	
Magnesia	0·16	
Phosphoric acid	0·12	
Moisture	0·13	
Oxide of copper	0·04	
		100·16

Mixture used—

Mine	2,500	
Shale	160	
Lime	260	
Anthracite	430	
		3,350

Cinder, dark green; iron, very tough and soft, but stood no heat, and was in every respect similar to iron made in Experiments 1 and 2. The anthracite used was from Glyn Neath, and of the very best quality, being nearly free from sulphur; and to show that it had no influence on the quality of the iron; it may be mentioned that large quantities of very good welding cast steel was made from the Cornham Ford ore, this anthracite being used as the reducing agent. In some experiments on steel made from Cornham Ford ore, too small a quantity of wood charcoal was used; the result was a very dark cinder with a metallic face, and a button of very soft iron, which would not stand a welding heat, but crumbled to pieces.

An experiment was made with a small amount of binoxide of manganese, added to ½-lb. of cable bolt, with a little shale and lime to form cinder, a small portion of carbon insufficient for the complete reduction of the oxide being added. The iron was similar to that obtained in other experiments, except that it stood the welding heat a little better.

Experiments were made with iron turnings from best cable bolt mixed with fine sand from pounded conglomerate; the object being to ascertain whether the iron took silicium from the pot. Three oz. of fine iron turnings, and 2 oz. of sand were mixed together intimately, and heated for two or three hours at a temperature sufficient to melt wrought iron. The turnings were fused into small buttons varying in size; the sand fritted together quite hard, especially at the bottom. On dissolving these buttons in hydrochloric acid, no silicium was detected; they could be readily flattened by hammering into thin plate.

Another experiment was tried by mixing iron turnings with sand and carbon; it was then found that the silica was reduced and combined with the iron, which fused into hard brittle buttons, containing from 1 to 2 per cent. of silicium (silica obtained in analysis was found to contain some iron).

The property of becoming useless after exposure to a welding heat appears from the above experiments to be a special character of fused wrought iron. The experiments have not been carried far enough to lead to any explanation of this; it may probably be due to the absence of a small portion of carbon usually present in wrought iron. In Bessemer's iron Mr. Riley believes there is no carbon, yet it certainly welds, but not very well. Wrought iron made directly from the ore appears to be rather worse than the fused bar or plate iron, as it crumbles to pieces when subjected to a great heat.

Mr. Riley intends continuing these experiments during the winter, and trusts eventually to be enabled to give some reason for the peculiar properties of fused wrought iron above described.

ON MOLTEN SUBSTANCES.

By J. Nasmyth, Esq., C.E.

Paper read before Section G, British Association.

The author's object in this paper is to direct the attention of scientific men to a class of pheuomena which, although in their main features they might be familiar to practical men, yet appeared to have escaped the attention of those who were more engaged in scientific research. The great fact which he desired to call attention to is comprised in the following general proposition—namely, that all substances in a molten condition are specifically heavier than the same substance in an unmolten state. Hitherto water has been supposed to be a singular and special exception to the ordinary law—namely, that as substances were elevated in temperature they became specifically lighter; that is to say, water at temperature 32° on being heated does on its progress towards temperature 40° become more dense and specifically heavier until it reaches 40°, after which, if we continue to elevate the temperature, its density progressively decreases. From the facts which Mr. Nasmyth brought forward, it appears that water is not a special and singular exception in this respect, but that, on the contrary, the phenomenon in relation to change of density (when near the point of solidification) is shared with every substance with which we are at all familiar in a molten state, so entirely so that Mr. Nasmyth felt himself warranted in propounding, as a general law, the one before stated—namely, that in every instance in which he has tested its existence he finds that a molten substance is more dense or specifically heavier than the same substance in its unmolten state. It is on account of this that if we throw a solid piece of lead into a pot of melted lead, the solid, or unmolten metal, will float in the fluid or molten metal. Mr. Nasmyth stated, that he found that this fact of the floating of the unmolten substance in the molten holds true with every substance on which he has tested the existence of the phenomenon in question. As, for instance, in the case of lead, silver, copper, iron, zinc, tin, antimony, bismuth, glass, pitch, resin, wax, tallow, &c.; and that the same is the case with respect to alloys of metals and mixtures of any of the above-named substances. Also, that the normal condition as to density is resumed in most substances a little on the molten side of solidification, and in a few cases the resumption of the normal condition occurs during the act of solidification. He also stated that, from experiments which he had made, he had reason to believe that by heating molten metals up to a temperature far beyond their melting point, the point of maximum density was, as in the case of water, at 40° about to be passed; and that at such very elevated temperatures the normal state, as regards reduction of density by increase of temperature, was also resumed, but that as yet he has not been able to test this point with such certainty as to warrant him to allude further to its existence. Mr. Nasmyth concluded his observations by stating that he considered this to be a subject well worthy of the attention of geologists, who might find in it a key to the explanation of many eruptive or upheaving phenomena which the earth's crust, and especially that of the moon, present—namely, that on the approach to the point of solidification molten mineral substances then beneath the solid crust of the earth must, in accordance with the above-stated law, expand, and tend to elevate or burst up the solid crust—and also express upwards, through the so cracked surface, streams more or less fluid of those mineral substances which we know must have been originally in a molten condition. Mr. Nasmyth stated, that the aspect of the lunar surface, as revealed to us by powerful telescopes, appeared to him to yield most striking confirmation of the above remark. He concluded by expressing a hope that the facts which he had brought forward might receive the careful attention of scientific men, which their important bearing on the phenomena in question appeared to him to entitle them to.

GUN-BOATS FOR INDIA.

The Hon. East India Company, seeing the advantage which a flotilla of gun-boats, of small dimensions and light draft of water, would be to keep the water communication completely in the possession of the Indian Government (and thus, should any disturbance arise, the main and natural means of transport and conveyance would be always available), have ordered Messrs. George Rennie and Sons to construct several small gun-boats on their patent principle.

The dimensions of these vessels are as follow, namely:—Length, 70 ft.;

beam, 11 in.; draft of water, 2 ft. forward, and 2 ft. 6 in. aft, with from 5 to 6 tons of coal on board.

There are two engines, each of 10 H.P., horizontal and direct-acting, each engine being entirely independent of the other, and driving a separate screw propeller, one under each quarter, the intended number of revolutions of which are 320 per minute.

The gun is a long brass 12-pounder, 18 cwt., and pivotted so as to allow the gun to traverse in a circle, and thus command both sides of the river.

During the last month several trials and experiments have been made with the first of these vessels, under the superintendence of a Government engineer. The average speed of six runs was found to be 9 knots, or 10¼ miles, the engines making an average number of 350 revolutions per minute.

The indicated power being	76 horses
Pressure in boiler	50 to 60 lbs.

These vessels were found to turn in a very narrow compass, from the facility of backing or stopping one engine while the other went a-head, which it is considered will be of great advantage in some of the small creeks and narrow parts of the upper rivers.

These vessels are divided into three water-tight compartments, the after part being fitted with a deck-house, adapted for the hot climate of India, in which the crew, as well as the captain, who has a separate cabin, are accommodated. The fore part of the vessel is arranged for the powder magazine, shell-room, store-rooms, and cooking galley, &c., and the centre part for the engine, boiler, and coals.

Several of these vessels are now in course of shipment; and from the facility of putting the parts together, it is expected that in a few days after their arrival in India they will be fit for service.

A few of these boats would be of infinite service up the narrow creeks and turnings of the rivers beyond Canton, where Captain Keppel so distinguished himself in the row-boats of the ships; and we cannot but think that the Government would do well by sending some such boats out before the China war is over, more especially as we see the President of the United States mentions, in his message, the intention of his Government to send out ten gun-boats of shallow draft for the Chinese service.

NOTICE TO ANNUAL SUBSCRIBERS.

In accordance with the notice addressed by the Proprietor to the Readers of The Artizan in the December Number, inviting them to send in their names as Annual Subscribers, very many have promptly responded to the invitation, and it is hoped that the number of Annual Subscribers will be very materially increased during the month of January, that the improvements which have been contemplated in connection with the Journal may be fully carried out.

Every Annual Subscriber will in future be entitled each year to receive free a proof impression, printed on thick plate paper, of any one of the Engravings which have been published during the last three years, or of any which may hereafter be published in "The Artizan;" and they may also obtain any additional number of proof impressions at the following prices:—

Quarto Plates, 1s. each; double quarto, 2s.; and any larger size, at 3s. each. India Proofs will be charged double the above prices.

Annual Subscribers, to whom these privileges are alone extended, in availing themselves thereof, must, at the time of applying, produce the receipt for his subscription, or supply the printed consecutive number of his receipt, whereupon the Plate which he may have selected will be delivered to him at the Publishing Office.

INSTITUTION OF CIVIL ENGINEERS.

November 24, 1857.

Robt. Stephenson, Esq., M.P., President, in the Chair.

The proceedings were commenced by the reading of an appendix to Mr. G. L. Molesworth's Paper On the Conversion of Wood by Machinery.

The manufacture of casks by machinery was cited as an example of a branch in which many failures had occurred, in consequence of the machines having been frequently designed without a view to effecting economy of material, so that the waste of valuable wood was not counterbalanced by the saving of labour. The best machines in use for performing the following processes in the manufacture of casks were briefly described.

The process of cutting up the "blanks" into staves, either by circular, or by reciprocating saws, and of converting without waste irregular and twisted "blanks" into staves, by the use of weighted rollers pressing the work against an adjustable fence in the saw frame.—The cutting out "tonguers" and "doublets" by a travelling template, which determined the position of the fence; and the plan adopted at Her Majesty's Dockyard, at Deptford, for irregular "blanks," "tonguers," and "doublets;" as well as the American mode of cutting staves for dry casks.—The process of jointing by moving the stave through a curved path in the direction of its length against circular saws.—Robertson's mode of backing staves, by passing them on a travelling platform under cutters; and Green's mode of passing them over a pair of cutters arranged on each side of a guide collar, whilst the stave was pressed down by a heavy fluted feed roller.—The processes of "trussing" on Rosenborg's principle, by a series of radial forcing levers, actuated simultaneously by screws, and on Robertson's principle by means of strong cones, into which the staves were forced by hydraulic pressure.—The plan of "crozing and chining" by turning the cask up on a vertical lathe, after trussing; or by passing each stave separately under cutters.—And the process of finishing the heads with an oval motion, to allow for shrinkage of the wood across the grain; thus completing the different processes in manufacturing casks.

Hamilton's machine for sawing curved ship timbers was described as having an inner gate, and the blade so hung as to allow of a transverse as well as a swivelling motion, for curvilinear work, the log being so arranged as to be turned on its axis whilst travelling, and to be cut to any desired bevel. Green's method of adapting an indicator roller to this machine, for cutting variable bevels from a small scale diagram, was also mentioned.

The largest circular saws were stated to be those used for cutting veneers from the log; their size, velocity, and mode of action were given, as well as the attempt to supersede them by a revolving knife edge, with the causes of its failure. The Russian method of cutting veneers was briefly touched upon, as well as the reasons for its non-adoption in England; and the French method, with a reciprocating knife edge, was also described.

A description of Jordan's wood carving machinery was given, with his method of producing a species of floating movement in the table carrying the pattern and the work, under a frame furnished with a series of drill cutters and a tracing knob, so as to produce several copies simultaneously from one pattern;—the plan of carving under-cut parts by swivelling the pattern and work simultaneously, was also described.

The appendix concluded with an account of Messrs. Ransome and May's manufacture of compressed railway keys and trenails, and also of the mode adopted in Her Majesty's Dockyard, Portsmouth, of shaping trenails cleft from timber of irregular or twisted grain.

A description was given of Wilson's machinery at the Midland Counties Timber Company's Works at Banbury, for the conversion of wood into mop and broom handles, of which very large quantities were manufactured. Cylindrical gouge cutters were used, so that by turning them gradually in their sockets, they always presented a cutting edge, which would work for sixteen hours without sharpening; and a tool would last three months. The surface produced was excellent, and the machine was now about to be used for making pencils.

The carving machinery invented by Mr. Jordan, and used for the decorations of the New Palace, at Westminster, was alluded to; and a description was given of the ingenious machines, also invented by him, for making the frames of school slates, at Colonel Pennant's Quarries, near Bangor. The logs of American birch were first cut up by frame saws; the planks were then seasoned for six months, and were afterwards cross cut to proper lengths—passed over a series of circular saws and grooving cutters alternately fixed on the same shaft—the mortises and tenons were cut in two other machines—the end mortises, tenons, and shoulders, were then cut, and the slates encircled by four of these pieces. The frame thus formed was then laid against two stops, and a pair of drills descended upon the opposite corners, making two holes; it was then reversed, and another pair of holes were made in the other two corners; pegs were inserted, and the work was completed. Up to that point the result was excellent, but it had been found impossible entirely to finish the work with the delicacy with which the human hand could do it. In all such machinery the vital importance of high speed and perfect balance were insisted upon, and many curious instances of failure, resulting from neglect of these points, were given.

Messrs. Ransome and May's trenail and key machines were further described, and the advantages of the pendulum saw for cross cutting were strongly insisted on.

Green's stave-cutting machinery was explained, and the great quantity of work which could be executed by it was shown.

Gibson's Self-acting Railway Signals.

After the meeting a model was exhibited of Gibson's self-acting Signal and Telegraph for Railways. This apparatus was described as being intended to supply the want of a system of railway signalling, which

should be efficient, and, whilst answering every purpose for which railway signals could be required, should be simple in construction, and not liable to be misunderstood, or to get out of repair; being, at the same time, independent of the attention or the neglect of servants.

The apparatus consisted of a continuous arrangement of signalling set in motion by the engine, which, in passing over a lever placed close withinside the rail in any desired situation, caused a signal-post (No. 1) to rotate partially, and so to indicate to the following train the close proximity of a preceding train. The signal post (No. 1) remained in this position until the engine arrived at the next signal post (No. 2), the lever opposite to which, when depressed by the engine, caused it to rotate similarly to the signal-post (No. 1) previously passed, which was at the same time replaced in its original position. The engine then reached signal-post No. 3, and it and No. 2 would be simultaneously acted upon as were Nos. 1 and 2. Then No. 4 received the responsibility, and released No. 3, and so on. It answered equally well by night and day, and the present signal-posts could be adapted to it.

By the same motion of the horizontal levers audible or visible telegraphic communications could be made with any station, or stations, either in advance or in the rear of the moving train; thus indicating, by the continual ring of a bell, if necessary, the approach, departure, present position, or passage through a tunnel, or over any dangerous part of the line. On foggy or stormy nights, or where there were sharp curves, &c., this would be found very valuable.

Another important part of the system was the contrivance for the self-acting contraction and expansion of stretched wire, by means of which hand signals, &c., could be acted upon at a distance of 2,000 yards, being far beyond the present working distance, and the wire, both in summer and winter, would always be at the same degree of tension.

The whole apparatus was described as having been in efficient action for some time at Binn's Junction, on the North Eastern Railway, where thirty trains ran daily over it, to the perfect satisfaction of the engineers and the officers of the line.

December 1, 1857.

Robt. Stephenson, Esq., M.P., President, in the Chair.

The Discussion upon Mr. Molesworth's Paper On the Conversion of Wood by Machinery, was continued throughout the evening.

Exception was taken to the Author's preference for the wood framing generally used in America. It was admitted, that whilst it was new it might be sufficiently steady, and might absorb or neutralise the vibration: but it was asserted that the screws soon worked loose, the joints became slack, and the framing trembled. On the other hand, however, cast-iron framing was more durable, the joints continued firmly attached, and the whole fabric remained steady; it was easy to neutralise the vibration by inserting beneath the plummer blocks, sheet lead, or strips of wood, which prevented any jarring, and the shafts continued to run evenly for a greater length of time.

The timber most worked in America was soft, and did not require such careful working or such a smooth surface as that worked in England, where, on account of the higher price of the material, it was necessary to avoid cutting any timber to waste.

Great difficulties had been originally experienced in setting circular saws, so as to make them run truly; but since a soft packing had been adopted they could be run at much higher speeds, and the larger plates could be made much thinner. It was asserted that none of the American circular saws could produce such a good surface on flooring boards as could be given to them by the fixed planes, under which the boards travelled. It was only necessary to keep the planes in good order, and to make the boards travel sufficiently quick. Straight-planing could be performed at the rate of 50 ft. to 60 ft. per minute, by fixed planes; whilst the edges of the boards could be worked off square, or be ploughed and tongued by circular cutters. The speed of the circular saws in this country rarely exceeded 7,500 revolutions per minute; at that speed thin saws were worked, whilst those used in America were much thicker.

A description was given of a simple mode of planing on the timber sleepers the seats for the iron railway-chairs. The sleepers were fastened, with their faces downwards, upon a carriage, travelling on a small railway; and two revolving planes, working upwards, cut the seats simultaneously, with perfect precision, both as to depth and parallelism.

With respect to the forms of the teeth of saws, it was asserted that the gullet tooth, with the throats filed bevel alternately on either side, did the best work; but on the other hand, it was shown, that although that form was excellent for uniform timber, the ordinary "peg" tooth was a better form, in case of meeting with any knots or nails; as, if a portion of the peg tooth was accidentally broken, it continued to do its work almost as well as before.

The "parrot's bill" tooth was generally preferred for circular saws, and when cutting soft timber the number of teeth should be reduced.

At the large establishment of the late Mr. Thomas Cubitt, all the sawing was performed by circular saws, and beautiful specimens of work were exhibited. The timber could be cut to any angle by saws fixed in rising and falling spindles, some of which made as many as 6,000 revolutious per minute; the men, however, generally preferred about 3,000 revolutions. Any vibration was very prejudicial to the work, and it was essential that every part of the high-speed machinery should be perfectly balanced. The question of speed resolved itself into the consideration of quantity against quality; the greater the speed the coarser would be the quality of the work done.

On behalf of American tools it was urged that they were found sufficiently strong and steady for the work they had to perform. They were cheaper, and the wooden frames could be easily and cheaply renewed when they became unsteady. The bearings lasted longer than upon iron frames. The American saws had fewer teeth than the English, and were found to cut cleaner. The teeth were generally filed in triplets, the first with a bevel to the left, the second straight, and the third with a bevel to the right; thus they cleared themselves the more readily, and cut much cleaner. The rotating cutters were found to take less power for a given quantity of work than the stationary planes.

To this it was replied, that whilst the rotating cutters were sharp, they did good work, but they were much sooner worn down than the stationary plane, and then the surface produced was ragged. The common carpenter's plane was very nearly a perfect instrument, and the great object was to produce a machine which should, as nearly as possible, imitate its action, and by habit the workmen, in feeding the stationary planes, presented the wood to the tool in the manner best suited to the quality, and so as to accommodate the cut to the knots. Between 30,000 ft. to 40,000 ft. of flooring boards could be produced per week with a good stationary plane.

Smart's circular saws were originally about $\frac{1}{8}$th in. thick, thus wasting much timber. The late Sir Isambard Brunel then introduced the large veneer saws, put together in segments; Holland invented the system of packing the saws, and now they could be worked at very high speeds, when 36 in. diameter, and only 14 gauge in thickness. It was found advantageous to leave a space of 2 in. between the teeth, when the saw had its full diameter of 36 in. and when by constant sharpening the diameter of the saw decreased, the space between the teeth diminished in a regular proportion.

It was urged that the production of high finish by machinery was a difficulty but not an impossibility. Hitherto the study had been to produce quantity, and quality of work had been sacrificed to it. It was argued that the practice of wood working was not perfect, and that much might be done by due attention to the subject. The points which required the greatest care were undoubtedly high speed and perfect balance; and it was stated that the correct proportion of the speed of travel of work to that of the cutters was too generally overlooked. The American speed of $\frac{1}{20}$th of an inch travel for each stroke of the cutter, was given as applicable for ordinary purposes, but was far too slow a speed for high finish. The system of reducing the work, by sawing, as nearly as possible to its finished dimensions, was recommended; and the adoption of roughing cutters in some cases, and also cutting with the travel of the work, instead of against it, were stated to be conducive to high finish. The advantages of a solid bed, the proper angles of cutters, steady bearings, and cutters highly tempered and kept well sharpened, were insisted upon as indispensable to finish. It was urged that the Americans had made much more progress than the English in the appliances of machinery, and Mr. Whitworth's report was quoted as confirming this view; at the same time it was conceded that the machines which were manufactured by Worssam and McDowall were superior in workmanship to those of America.

A case of failure in the wooden frames, constructed in England, was said to have arisen from their not having been properly constructed; and it was urged that attention should be given in constructing them, to the quality and seasoning of the wood, as well as to the formation of the joints, which should not only be dependent on a mortise and tenon, but should be shouldered in and firmly secured. If properly constructed they were very durable, and they absorbed much of the vibration observable in the machines constructed with iron frames.

December 8th, 1857.

Robert Stephenson, Esq., M.P., President, in the Chair.

The paper read was, Account of the Steam Ferry over the River Nile, at Kaffre Azzayat, Egypt, by Mr. T. Sopwith, M. Inst. C.E.

This ferry was situated on the line of railway extending from Alexandria to Cairo, and was about midway between those places. It was intended to convey, temporarily, until a more permanent and fixed structure, now in course of erection, could be completed, the railway trains and engines between Kaffre Lais and Kaffre Azzayat, towns situated on opposite banks of the River Nile. After describing the general course of the line from Alexandria to Kaffre Lais—a distance of about 65 miles—the author proceeded to delineate the peculiarities of the site occupied by the ferry. The river, at the point in question, was in a horse-shoe form of about 3 miles in length, and included a tongue

of land, little more than a mile in width, along the middle of which the railway passed. The distance between the fixed platforms, or jetties, at the opposite sides of the river was 1,100 ft.

Ferry-boats guided by chains were in use in several parts of England, having been first adopted on a large scale by the late Mr. Rendel. The peculiarity of that over the Nile consisted in its having a moveable platform to receive the railway trains.

The several mechanical arrangements of the ferry were directed to facilitate the placing on the platforms the engine and carriages composing a train, with the passengers conveyed by it; to provide sufficient power for taking the ferry and its ponderous load across the river in a direct line from one jetty head to the other, and so to arrange the level of the ferry platform, as to enable it to coincide, at all times, with the line of rails at either side of the river—the variations of level of the waters of the Nile amounting to 27 ft. between the high and low Nile.

The framework rested on a flat-bottomed and shallow barge of oblong form, with the corners taken off, no attempt having been made to give it the form of a ship. The length of this barge was 80 ft., width 60 ft., and height 60 ft.; the draft of water when loaded was 3 ft. 6 in., and when unloaded 3 ft. It was worked by two steam-engines, each of 15 H.P., placed horizontally on each side, which sufficed to take the ferry and its load across the river in about six minutes. The two chains were 28 ft. apart, and passed just outside the standards. The wheels were 9 ft. in diameter, and twelve strokes of the engines gave one revolution of the wheels. The barge was entirely of wrought iron, and consisted of eight transverse main ribs, turned up at each end against the sides of the vessel, and two longitudinal ribs extending from end to end of the vessel. Upon these ribs was erected the framework which contained the moveable platform, consisting of iron standards, corresponding in number and in position with the ribs, supported, with the exception of those at the extremities, on the outer side by diagonal braces, forming flying buttresses, resting on the turned-up ends of the cross ribs of the barge. These standards were strengthened by horizontal beams and by diagonal bracing. The whole framework was surmounted by a rigid platform or deck of timber, at an elevation of about 60 ft. above the water; and intermediate between this deck and the boat was the moveable platform. This platform was composed of eight wrought-iron beams, one opposite each standard of the outer frame, covered by timber, having upon it a double line of rails, laid on longitudinal sleepers, exactly corresponding with the fished extremity of the railways on the jetties.

The arrangements for effecting the vertical movement of the middle platform were very simple:—To the front of each standard there was a cast-iron frame, extending from near the bottom of the boat to about 20 ft. below the top of the great frame. This frame had three vertical recesses—the two outer ones having teeth cast in them at intervals of 6 inches, so as to form racks—and being fixed in position alternately. In the middle recess was a strong wrought-iron ladder, with wrought-iron rungs at intervals of 3 inches. This ladder moved freely up and down the central recess, and was attached at the top to a screw operated upon by a capstan. A strong bolt sliding in a cast-iron socket at each end of the cross beams of the middle platform was so arranged as to work easily into the rack-like recesses. At the end of each beam there was also a strong rod jointed at the bottom, and terminating at the top in a hook, so as to lay hold of the rungs of the ladder. Whilst one man on the middle platform worked the bolts and adjusted the hooked rod, another on the upper platform turned the capstan, and thus the platform was raised or lowered, by intervals or steps, of 3 inches at a time. The last length of rails on the jetties was placed on a hinged platform, so that an exact coincidence of level could always be ensured. Simple means were adopted to ensure the simultaneous action of all the capstans, so that the intermediate platform should be moved uniformly.

The ferry had been in operation for the last eighteen months with perfect success. It was designed by the Engineer-in-Chief of the line, Mr. R. Stephenson, M.P., President, and the several parts of the structure were manufactured at the works of Messrs. Stephenson and Co., at Newcastle-upon-Tyne, and afterwards fitted together on the spot for Mr. Edward Price, the contractor for the railway.

In the discussion further details were given of the construction and method of working the ferry; the cost was stated to have been £18,000, including the jetties at both ends, carried on Mitchell's screw piles, with projecting cylinders at the extremities; the method of sinking the cylinders was by Hughes' pneumatic plan of using a "plenum" instead of a vacuum; the mode of attaching the chains on the two shores was by having weights rising and falling within a cylinder at each extremity, to compensate for the drag upon the chains. The plain parallelogram form had been adopted because it was the best for giving great flotation, and affording that stability which was so necessary when the weight was at times raised high above the surface of the river, as at the times of low Nile. Speed was not an object when the traversing could be effected in six minutes which, in a line of 140 miles in length, was a mere fraction of the duration of the journey. Objections had been raised to delays which had occurred at the ferry, but it was shown that they were not to be imputed to any defects in the construction of the machine or in the manner of working it; but they were due entirely to the obstinacy and want of practical knowledge displayed in the general arrangements for the goods and passenger traffic of the railway—defects which, in fact, pervaded everything in Egypt.

It was for some time the custom on the arrival of the train at the ferry to make the passengers alight from the carriages, to put them into a steam-boat, convey them across the river, and oblige them to climb up the muddy banks to rejoin the railway carriages, which had meanwhile been conveyed across by the steam ferry in "empty grandeur." This was only equalled by the too common custom of obliging thousands of "fellahs" and their families, carrying all their worldly gear with them, when on their compulsory migratious as labourers on Government works, to walk for days parallel with the railway, along which they could have been so cheaply, and certainly more humanely conveyed. If the human race was not much considered in the Egyptian Railway arrangements, the goods traffic was not more attended to when cotton, which could be carried for two pence per ton, was charged fifteen pence, in order to force it to be still brought down by the Nile boats. As an illustration of the mode of management of the line, it was stated that at one period there was only one train each way every other day, although the natives had evinced a great desire to travel, and the line connected towns containing large populations. A hope was expressed that contact with the energetic engineers, in the service of the Pacha, would in due time break down such dilatory habits and perverse adherence to antiquated customs, and that the benefits anticipated from the establishment of the railway would be realised.

In the construction of the machinery of the ferry great credit was awarded to the late Mr. C. H. Wild and Mr. Dempsey for the details of the machinery; to Mr. George Robert Stephenson for the method of lifting the platforms; and to Mr. Rouse and Mr. McLaren for putting together and erecting the whole and making it work so thoroughly well.

Before settliug the design, the floating bridges invented and constructed by the late Mr. Reudel, at Plymouth and at Portsmouth, were carefully studied, and the parts most suited for the conditions of the Nile ferry were copied; these conditions were, however, so peculiar, that they rendered necessary a design of au entirely novel character, in which it was imperative to guide and control the passage across a rapid river with such precision as to bring the extremities of the rails together to pass the heavy railway carriages without difficulty. Such conditions were very different from those of floating bridges into which road carriages were drawn by their own horses, or were easily pushed by a few men, and of passengers who walked on board and on shore again. Thus no parallel could be established between the two adaptations of the same principle.

It was urged that these floating bridges were well adapted to certain positions in India, and a hope was expressed that when tranquillity was restored, these and other similarly useful works would be authorised by the Government.

It was objected that these steam ferries, although they were adapted for this precise position, could not be advantageously employed in India, where the rivers were numerous, and were frequently crossed by the railways; it was, therefore, contended that it would be undesirable that this Institution should appear to recommend the system generally. To this it was replied that good engineers did not adopt or apply systems of this kind indiscriminately, but used special machines for the situations to which they were fitted. The objections to the employment of these steam ferries, as not being adapted to the rivers of India, were easily shown to be ill-fouuded; it had not been contemplated to use them on the numerous small rivers, or on those which became torrents duriug the rainy season and were dry during the summer, but the system was well adapted to very wide rivers, where there was always plenty of water, and where the construction of permaucnt bridges would be disproportionately expensive—iu this early stage of Indian railways.

December 15, 1857.

Robert Stephenson, Esq., M.P., President, in the Chair.

ANNUAL GENERAL MEETING.

The Report of the Council for the past Session, which was read, stated, that the Indian mutiny had, for the moment, interrupted the progress of public works in that country, whilst the monetary crisis throughout Europe and in the United States had arrested nearly all professional occupation. Under these circumstances there were, comparatively, but few events to uotice. Allusion was, however, made to several undertakings which had occupied the attention of Civil Engineers during the preceding twelve months, including the unfortunate failure in the attempt to lay the submarine electric telegraph cable between this country and the United States; and the hope was expressed that this daring enterprise would be completed next year.

Meanwhile the electric cables between Cagliari and Malta, and between Malta and Corfu, had been successfully submerged, in spite of the great depths of the channels, and thus another considerable step towards

shortening the period of communicating between Great Britain and her Indian possessions had been accomplished. In connexion with this interesting topic, mention was made of the project, brought forward by Sir Macdonald Stephenson, Assoc. Inst., C.E., and Mr. J. C. Marshman, M.P., under a firman granted to Mr. Lionel Gisborne (Assoc. Inst., E.C), of a submarine telegraph to India by way of and along the Red Sea. It was intended to take the messages at Alexandria, convey them by the wires of the Suez railway (a privilege conceded by the Viceroy), to lay down a series of submarine cables from Suez to Aden, and thence to Ras-el-had, on the Persian Gulph, so arranging the intermediate stations that the unbroken length of each cable should not exceed 500 miles. Thence to Kurrachee, being only 400 miles across the Ocean, where a juuction would be made with the existing Indian telegraphs. The entire length of eable between Suez and Kurrachee would not be more than 4,000 miles, and the cost, it was believed, would not exceed £700,000.

Another great work was the *Leviathan* steam-ship, constructed by Mr. Scott Russell (M. Inst. C.E.), under the direction of Mr. Brunel, V.P., which, being now within reach of the water, there was good reason to believe, would be safely floated off the "ways" during the next high tides.

Among the works in an advanced state, the bridge erecting by Mr. Brunel, V.P., on the Cornwall Railway, for carrying the line across the River Tamar, at Saltash, near Plymouth, was prominently alluded to. This bridge, including the land openings, would be about 2,200 feet in length, and would cousist of nineteen openings, two of 455 feet span each, and the others varying from 70 feet to 93 feet in span. The latter were formed of simple wrought iron girders; but the two main openings were to be spanned by longitudinal beams, suspended by long-linked tension chains, rendered rigid by vertical struts and diagonal braciug, from arched tubes of wrought-iron plates. The transverse section of these tubes was elliptical, the horizontal axis being 16 ft. 9 in. in length, and the vertical axis 12 ft. Each tube with its chaius and suspended roadway would weigh about 1,080 tons. The first was floated on the 1st of September of this year, was conveyed upon pontoons to its site, and was placed upon the piers in about two hours. It was now being lifted by hydraulic presses, and the process was progressing very satisfactorily.

The new landing-stage at Liverpool, which had been recently completed from the designs of Sir William Cubitt, at a cost of about £110,000, was supported by 63 pontoons of a rectangular form, 49 of which were 80 ft. long and 10 ft. wide, and two at the extremities, 12 ft. wide and the same length; the remaining 12 were 96 ft. long and 10 ft. wide, so as to provide additional strength and floatation at the points where the four bridges, communicating with the quay, were attached to the stage. These pontoons were crossed at right angles by five wrought iron beams, or keelsons, each 1,000 ft. long; and these again were covered with strong cross-beams, 6 in. thick, and planked over with planks, forming a rectangular deck, 1,000 ft. in length, and 80 ft. in width, slightly curved in its breadth, being higher in the centre than at the sides throughout its whole length. This landing-stage had been in use for about five months, and appeared to give general satisfaction.

A further important section of the Grand Trunk Railway of Canada, now constructing by Messrs. Peto, Brassey, and Betts, under the direction of Mr. Alexander Ross, had been opened for traffic; so that the total length of the main line was now nearly 850 miles, with several branches. The piers of the Victoria Tubular-bridge, which was to span the River St. Lawrence, were fast progressing; the two land abutments and fourteen of the piers having been completed, and one of the wrought iron tubular girders was already in position. When completed, this bridge, which had been designed by Mr. R. Stephenson, M.P., President, would be nearly two miles in length, and would consist of twenty-five openings, spanned by tubes of wrought iron, like those of the Britannia Bridge.

In connexion with this line of railway an arrangement had been organised by Mr. S. P. Bidder, the general manager, by which passengers of all classes could be booked through from all the principal emigration ports of this country, or the Continent, to their several destinations, in any part of Canada or the United States. This facility had proved to be a great boon to emigrants.

The Rivingtou Waterworks of the Liverpool Corporation, constructed by Mr. Hawksley, M. Inst. C.E., were brought into operation in the early part of the present year. The works consisted of several impounding reservoirs, two of which had embankments of nearly 100 ft. high, and two others with embankments of about 50 ft. high. These reservoirs held about 3,200,000,000 gallons, and were iutended to deliver about 14,000,000 gallons per day, to the inhabitants of Liverpool, and 9,000,000 gallons per day to the mill-owners and others whose interests were affected by the works. After being stored, the water was passed through a cast-iron main-pipe of 44 in. diameter, and 23 miles in length. Great difficulties were encountered in constructing the works, in consequence of the variable character of the ground upon which the main embankmeuts and other retaining works had to be constructed. In was deemed necessary, in several instances, to excavate the puddle trenches to depths of 50, 60, and even 70 ft. below the surface of the ground. The cost of the works, land, parliamentary, and local inquiries, had reached about £750,000: but of this sum it was estimated that £150,000 had been expended upon, and in consequence of, the contentions of the local authorities. In addition to this outlay, the purchase and improvement of the works of the two companies by which Liverpool was formerly supplied with water, had amounted to about £850,000. Hence the total cost, to the present time, of providing water for the inhabitants of Liverpool and its neighbourhood, numbering altogether about 500,000 persons, was upwards of one million and a half sterling, or somewhat more than £3 per head. The two works together were, however, capable of supplying 20 gallons per head per diem to 1,000,000 of people.

The supply of water for Glasgow was now being furnished from Loch Katrine by very extensive works, designed and executed under the direction of Mr. Bateman (M. Inst. C.E.), who, it was hoped, would give to the Institutiou an account of this large undertaking.

The Bombay Waterworks, under Mr. Conybeare, M. Inst. C.E., were rapidly approaching completion. They were chiefly remarkable for the large population—700,000 persons—supplied from a single establishment; the reservoir, or artificial lake, at Vehar, 14 miles distant, nearly 1,400 acres area, with a maximum depth of 80 feet. It was formed by damming up three outlets of the central basin of the Island of Salsette; the rapidity of execution, and the economy of construction of the works, were also deserving of atteution. The works were on the gravitating principle, and the water was to be conveyed to Bombay by a double line of conduit pipes of cast-iron.

Very extensive works were now in progress, under the direction of Mr. G. P. Bidder, V.P., and Mr. George Robert Stepheuson, M. Inst. C.E., for the Netherlands Land Enclosure Company, with the object of reclaiming a tract of land which had been inundated in the 17th century by the overflowing of the Eastern Scheldt, near Bergen-op-Zoom. The Act of Concession granted by the Government, conveyed to the Company a freehold lease for 99 years, stipulating, in return for the permission, to reclaim 35,000 acres, that there should be constructed a barrage or bank across the Eastern Scheldt, so as to close up the passage on the east side of the Island of South Bevelands; a ship canal 18 ft. deep across the Island, with locks, 50 ft. wide, swing bridges, harbours, piers, &c., so as to compensate for the closing of a portion of the Scheldt. The barrage would be about 2½ miles in length, and eventually the proposed railway, connecting Dusseldorf with Flushing, would run upon it. In 1856 the first polder of an area of 1,100 acres was successfully enclosed; during the present year another polder, containing 1,700 acres had been reclaimed, aud in future annual enclosures would be effected. The land so reclaimed was of a most fertile quality, and large crops of Colza had already been produced on the first polder.

The principal papers read during the Session were then noticed, and it was remarked that as usual the discussions occupied a longer time than the reading of the papers, and would be found to add greatly to the interest of the Minutes of Proceedings.

The members were strongly urged to continue to present copies of scientific and professional works for the Library, without which its utility for reference and consultation could not be maintained.

The deceases of the members during the year were announced to have been:—Messrs. A. H. Bampton and J. Potter, members; Messrs. T. Clark, G. Cowen, D. S. Dykes, G. Hennet, J. Horne, J. Hunter, W. Parsons, M. K. Smart, G. H. Saunders, and G. Wilkie, associates; and Messrs. T. E. Ainger aud G. Ellis, graduates. The memoirs of these gentlemen were given in the Appendix to the Report. The resignations of two members and eight associates were announced, and it was stated that the effective increase during the year (after deducting the deceases and resignations), amounted to 45, whilst the total number on the books was 836 members of all classes.

The statement of the receipts and expenditure showed that there was a balance of upwards of £700 in the hands of the Treasurer; and that the financial position was in every respect satisfactory, the printers' and lithographers' accounts for all the minutes issued up to this date having been discharged, and there being now no liabilities outstanding.

During the year the second part of volume 10, and the whole of volume 13, of the Minutes of Proceedings, had been published and issued. There now only remained, to complete the series of fifteen volumes, extending over tweuty years, the second parts of volumes 7 and 8. Volume 16, for the past session, was nearly ready for issue.

It was stated that during the vacation it had been determined to recognise the services of Mr. Charles Manby (as the Secretary during eighteen years) to the Institution, by the presentation of a testimonial. The proposition was eagerly received, and such an amount was promptly subscribed as enabled the Committee to devote a portion to the purchase of a Clock and pair of Candelabra, which, with a check for £2,000, were presented to Mr. Manby by the President, in the presence of the members, in the Theatre of the Iustitution. In returning thauks for this mark of friendship and good will, Mr. Manby requested permission to devote some portion of the amount to the establishment of an annual premium, with which he begged that his name might be associated. He had accordingly transferred to the Institution the sum of £200, in 5 per

cent. debentures, the interest of which (£10 per annum) it was proposed to award to the authors of papers read at the Meeting, to be denominated the "Manby Premium."

It was announced, also, that the Report of the Committee conducting this matter would, with the names of the contributors, be published in the volume of the Minutes of Proceedings for the past session.

It was also stated that Mr. George Ritherdon, who had for upwards of fifteen years filled the situation of Cashier and Collector, was now compelled by failing health to retire, and it was recommended that a pension of £50 per annum should be voted to Mr. Ritherdon, in recognition of his long services to the Institution.

The report concluded by impressing upon the members redoubled zeal on behalf of an Institution which had exercised and must ever possess such beneficial influence on the profession of civil engineering.

After the reading of the report, Telford Medals were presented to Messrs. D. K. Clark, R. Hunt, F.R.S.; G. Rennie, F.R.S.; and W. B. Adams; and Council Premiums of Books to F. R. Window, G. B. Bruce, A. S. Lukin, C. E. Conder, W. Bell, F. R. Conder, and T. Dunn.

The thanks of the Institution were unanimously voted to the President for his attention to the duties of his office; to the Vice-Presidents and other members and associates of Council, for their co-operation with the President, and constant attendence at the meetings; as also to the Auditors of the accounts and the Scrutineers of the ballot, for their services. A special vote of thanks was accorded to Mr. C. Manby, Secretary, for the manner in which he had performed the duties of his office, his constant attention to the individual wishes of the members, and for his liberal donation to form a fund for an Annual Premium, which it was resolved should be permanently marked by the establishment of a "Manby Premium."

REVIEWS.

Metropolis Management; or a Few Words on the Present Position of the Local Boards and the Public generally, in reference to the Gas and Water Companies; with Suggestions for the Future. By Samuel Hughes, F.G.S., Civil Engineer, author of "Treatises on Gas and Water Works." London: Edward Stanford. 1858.

This pamphlet consists of two parts, the first relating to the gas supply of the metropolis, and the second relating to the water supply.

The author reviews the effects, present and prospective, of the recent combination entered into by the gas companies to parcel out the metropolis amongst themselves. He points out the effects of this combination, with reference to the public lighting of the streets, and quotes many cases of great inequality in the charges made for lighting various parishes in the metropolis. The authorities of Marylebone, and several other large parishes, have been holding meetings to complain of the increased charges imposed by the gas companies since this combination. But Mr. Hughes shows that the district of Westminster has probably suffered more from the combination than most of the other London parishes. He points out also the injury, in the shape of increased price and diminished quality, which will probably fall on the private consumers, in consequence of the combination of the gas companies. Under these circumstances he calls on the various district boards, established under the authority of the Metropolis Management Act, to do one of two things—either to establish parochial gas works, or unite in obtaining an Act of Parliament to control the gas companies, in a variety of ways, in order that the public may have efficient protection, and such combinations be prevented in future. Reference is made to the brilliant results attained by the Corporation Gas Works, in Manchester, which have been established more than forty years, and though selling their gas at 1s. per 1,000 feet less than the price charged for similar gas in London, have yielded a profit of £30,000 a year, which profit has been laid out in procuring a new water supply, and establishing museums, public halls, and parks.

The portion of the pamphlet devoted to water supply comprises a review of the principal provisions of the Metropolis Water Act, 1852, and shows how very important these provisions are for enabling consumers to obtain a constant supply of water at high pressure, an improvement which would at once supersede both fire engines and fire insurances.

The beneficial effects of these improvements are illustrated by reference to Amsterdam, Manchester, and other places; and the author strongly urges the necessity for a combined effort to secure them for the metropolis.

The pamphlet contains some very valuable statistics on the subject of street watering, and shows from returns by the water companies, and from other sources, the great inequality at present prevailing in the prices charged by different companies. Actual experiments during an entire year have been made in the Westminster district to determine the quantity really used for street watering; and it appears from these experiments that most of the London parishes are paying at least double the value of the water supplied to them.

The greatest ignorance as to the quantity actually necessary for street watering appears to prevail, both amongst the water companies and the local boards.

The experiments in Westminster have been made by Mr. Arntz, the surveyor to the Westminster District Board of Works; and we have thought the subject of so much importance at the present juncture as to justify us in giving Mr. Arntz's report at length in our next.

On the whole, we can highly recommend Mr. Hughes' pamphlet to the notice of all who are interested in the economics of town management. The extensive information it contains, as well as the valuable suggestions, are well worthy an attentive study by members of metropolitan boards and their officers, as well as by all who are interested in municipal affairs, either in London or the provinces.

Memoirs of the Geological Survey of Great Britain, &c.; Mining Records and Mineral Statistics of Great Britain and Ireland for the Year 1856. By Robert Hunt, F.R.S. Longmans. 1857.

The extraordinary increase which has taken place in the productions of the mining industry of the United Kingdom during the year 1856, is one of the most remarkable things which has come under our notice; and when we instance the enormous amount to which the annual production of coal has reached, viz., 66½ millions of tons, the vast importance of accurate returns of the products of mining industry will be readily appreciated.

Mr. Robert Hunt, whose world-wide fame as a philosopher, and well-known accuracy as a statistician, needs no mention here, has for some years past prepared annually a statistical account of some of the mineral resources of the British Empire. The present volume, for the year 1856, contains returns as to tin, copper, lead and silver, zinc, iron pyrites, arsenic, nickel, uranium, and iron, amongst the metals; and of coals, salt, clay, and building stones, and other productions raised or quarried out of the earth. These possess considerable interest, as, in addition to the *quantities* of these materials produced, much information, which will be found available in many respects, is interspersed throughout the work; and not the least so will be found the only complete *Collieries' Directory* which we ever saw, or which has, we believe, ever been completed. This gives the names and districts of the various Government inspectors of mines throughout the empire, and the number of the pits, and the names of the owners, and the situation of each of the works.

The Carpenter's and Joiner's Assistant, &c. Blackie and Son, London, &c. Parts 1 to 4.

We have received four parts of a new work published by Messrs. Blackie and Son, which is got up in the style of excellence for which they are justly celebrated. How for two shillings per number the costly work now before us (if the parts are fair specimens) can be sold at a profit, is a marvel, as they each contain five or six copper-plate engravings, executed in first-rate style, by such eminent artists as W. J. Lowry, J. H. Le Keux, and W. A. Beever. The wood cuts, too, are excellent in their way.

Of the textual portion of the work already published we are able to express an equally favourable opinion as to the style of typography, and the quality of the matter.

In the first number Practical Geometry is treated of in an accurate and masterly manner, by which the student is fully and fairly inducted into that important branch of mathematical science which treats of the properties and proportions of bodies, and of the combinations of lines, upon which the correct construction and development of figures depend.

In the next and following number the construction and use of drawing instruments are described; and in the fourth number the third division of the scheme of the work is treated of, under the title of stereography, or the projections of solids, and the linear composition of the sections and boundary lines of solid figures and constructions.

Now the works of Peter Nicholson, and other authors of treatises on carpentry and joinery, useful as they have been in advancing these practical arts to their present eminent position, are found by the student of the present day to be wanting in many respects, and, unlike the more modern treatises on those branches of mechanics, applied to works of construction in metal, steam machinery, &c., they have not kept pace with the advancements which have progressively (but perhaps not so rapidly) been made in the application of wood to structural works; hence the opportune appearance of the present publication will be hailed as a boon by the student in these branches of practical mechanics.

Rudimentary Treatise on the Marine Engine, and on Steam Vessels, and the Screw as a Propeller. By Robert Murray, C.E. Third Edition. John Weale. 1858.

We strongly recommend this new edition of Mr. Robert Murray's excellent and justly celebrated "Rudimentary Treatise on the Marine Engine" to all classes of our readers, as they will find much that is

valuable and interesting therein. Mr. Murray having made very many useful additions relating to development of screw propulsion, and other matters of general interest to the engineer and student.

A Practical Treatise on Cast and Wrought Iron Bridges and Girders, &c. By William Humber, Assoc. Inst. C.E., &c. Spon, Bucklersbury. Parts 23 and 24.

These are the concluding parts of this valuable treatise. The excellence of the illustrations, as to selections of subjects and the style of execution, have perfectly justified the commendation we bestowed upon them in noticing the first parts of Mr. Humber's work; and if, as we could have desired, a larger amount of equally well-selected textual matter, of a thoroughly practical character, had been given, we fear the original limits within which the author pledged himself to his subscribers to complete the work, would have been considerably exceeded; but we trust the subject will be hereafter treated in continuation, and in the direction we have indicated.

On Iron Shipbuilding, with Practical Examples and Details, in Twenty-four plates; together with text, containing description, explanations, and general remarks, for the use of ship owners and ship builders. By John Grantham, C.E., Consulting Engineer and Naval Architect. John Weale, London. 1858.

The steady progress which iron, as a material for shipbuilding, has made within the last few years, has rendered it a matter of surprise that no thoroughly practical and comprehensive work on the construction and build of iron ships has been published.

When, in 1842, Mr. John Grantham's address to the Liverpool Polytechnic Society, of which he was the president, brought prominently before the meeting the merits and capabilities of iron as a material for shipbuilding, the interest which attached to that portion of Mr. Grantham's address was extensively acknowledged, and resulted in a very general request that the Paper should be published in the form of a pamphlet, accompanied with illustrations of the mode in which iron vessels had been built; and this work served very materially to awaken public attention more extensively to the merits of iron ships, and helped to dispel the cloud of prejudice which enveloped the minds of very many ship owners, and others who had been taught to believe that "there was nothing like timber:" at least, for the construction of ships.

To say that the address of the president of the Liverpool Polytechnic Society, in 1842, and the publication of the substance of that address subsequently by Mr. Grantham, in the form of a pamphlet, have materially advanced iron shipbuilding, would be saying but little as compared with the practical benefits which have been effected by them; and whilst numerous books of more or less practical value have been published, about the kindred improvement connected with naval architecture and steam navigation (which came before the public about the same period), viz., the screw propeller, iron shipbuilding seems to have been left to take its chance amidst the busy throng of practical men engaged in that great branch of the industry of this country, to which it almost exclusively and more particularly belongs. For it must be presumed that they have been too much occupied with the practical operations of their businesses to permit of their employing their time in writing upon the art in which they are engaged, and so we have been prevented from benefiting by a thorough exposition of the various improvements which have been introduced in the application of iron to such constructions. It therefore affords us much pleasure to find that Mr. Grantham has again come forward in the same cause, as no man is better able to handle this subject in a masterly and extended manner, if his professional engagements would but permit of his affording the time to the treatment of this important branch of industry.

Before proceeding further with our notice of Mr. Grantham's new work, we would take the opportunity of suggesting that it is very important, that, whilst many of the absurd regulations imposed by Lloyd's upon the builders and owners of iron ships should be revised, some stringent measures should be adopted with reference to the *qualities* of iron permitted to be used, more particularly in the construction of ocean going vessels, as we find that it is not an uncommon practice amongst the builders of iron ships to employ iron with fictitious marks, and we fear, not unfrequently with forged brands, to the damage of the reputation of the more honest of their trade, and often seriously to the prejudice of the progress of iron shipbuilding.

Mr. Grantham, in publishing his present work, treating of iron shipbuilding, has adopted what appears to us an excellent idea, as, by giving the text in a small form, and at a cheap price, his book may be placed in the hands of those to whom it will be exceedingly valuable—the artizans practically engaged in shipbuilding, as well as those for whose use it is dedicated, and to whom it is addressed, namely, ship owners and ship builders. The size of the volume of text is demy 12mo, and is uniform with Weale's excellent "Rudimentary Series." The plates, twenty-four in number, many of them of a very large size, and drawn with great accuracy to a large scale, form a complete series of illustrations, not alone of the practical methods of construction adopted in the building of iron ships, and exhibiting the details of every part of such structures, and the various improvements which practical skill and experience have suggested, but also the forms and proportions of the various kinds of iron used in the framing—the modes of jointing and rivetting the plates—of forming the intersections of one series of plates with another—these are all detailed with the accuracy which alone could be delineated by a thoroughly practical and experienced designer and constructor of iron ships.

But Mr. Grantham, not satisfied with describing and delineating the minutiæ, connected with the construction of the hulls of iron ships, gives a series of illustrations of the application of the same material to the construction of masts and spars; and that his treatment of the subject shall be as complete as possible, he has given several sheets containing illustrations of very complete and admirably arranged machines for plate-bending, shaped bar and angle iron cutting, and punching and shearing, and drilling and counter sinking machines; and also for the purpose of ensuring that the angle and other irons used in the framing shall not be damaged for want of knowledge as to the best construction of furnace in which they may be heated, Mr. Grantham has given views of an air-furnace designed for the purpose; and the same solicitude has been exhibited for the proper and economic heating of the rivets, and a very good arrangement of rivet hearth is also illustrated.

For rivetting by steam-power, Mr. Grantham has selected for an illustration of this class of machine Garforth's steam-rivetting machine, which is known to most of our readers; and, as if to "clinch" the practical and manufacturing part of the subject, Mr. Grantham, after illustrating cotters and pins, plate hoists, clams, bears, and dollies, rivet tongs, and other similar tools, gives a series of illustrations of caulking tools, and rivetting and inside and outside closing-hammers.

There are also a variety of other plates, all exceedingly valuable, as completely illustrating the subject; and we regret the very late period at which we received Mr. Grantham's exceedingly useful book, as, after having read it with great care, and minutely inspected the practical examples and details illustrated in the twenty-four large plates accompanying the text, we are unable this month to devote further space for a suitable notice of it, which we must reserve until next month, and conclude for the present by strongly recommending to our readers Mr. Grantham's work on iron shipbuilding.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

ART TREASURES EXAMINER: a Practical, Critical, and Historical Record of the Art Treasures Exhibition at Manchester in 1857. Folio (Manchester), pp. 300, cloth, 10s. (W. H. Smith.)

ARTHUR (R.)—A Treatise on the Use of Adhesive Gold Foil. By Robert Arthur. 8vo. (Philadelphia), pp. 86, cloth, London, 6s.

BARRUEL (G.)—Traité de chimie technique; appliquée aux arts et à l'industrie, à la pharmacie et à l'agriculture. Tom. III. 8vo. (Paris), 6s. 6d.

BEUDANT (F. S.)—Minéralogie et géologie. 12mo. (Paris), 5s.

CAMERON (C. A.)—Chemistry of Agriculture: the Food of Plants, including the Composition, Properties, and Adulteration of Manures. By Charles A. Cameron. Post 8vo. (Dublin), pp. 146, cloth, 3s. 6d. (Simpkin.)

CARPENTER'S Mechanical Philosophy, Astronomy, and Horology: an Exposition of the Properties of Matter, Description of the Heavenly Bodies, &c. &c. Post 8vo, 181 illustrations on wood, cloth, 5s. (Bohn's Scientific Library.)

DELAUNAY (Ch.)—Cours élémentaire mécanique, théorique et appliquée. 4th edit. 18mo. (Paris), 7s.

GREGORY (W.)—A Handbook of Chemistry, Inorganic and Organic, for the use of Students. By William Gregory. 4th edit., post 8vo, pp. 1030, cloth, 18s. (Walton.)

JAMES (J.)—History of the Worsted Manufacture in England from the Earliest Times: with Introductory Notices of the Manufacture among the Ancient Nations, and during the Middle Ages. By John James. 8vo, pp. 650, cloth, 25s. (Longman.)

JEANS (H. W.)—Navigation and Nautical Astronomy. Part 1, containing Rules for finding the Latitude and Longitude, and the Variation of the Compass. By H. W. Jeans. 12mo, pp. 284, cloth 4s. (Longman.)

PHILLIPS (P. L.)—The Principles of Agriculture, especially Tropical, and of Organic Chemistry, familiarly treated. By P. Lovell Phillips. 8vo, pp. 206, cloth, 7s. 6d. (Smith and Elder.)

ROGERS (S. B.)—An Elementary Treatise on Iron Metallurgy up to the Manufacture of Puddled Bars, built upon the Atomic System of Philosophy; the Elements operated upon being estimated according to Wollaston's Hydrogen Scale of Equivalents, &c. &c. By Samuel Baldwyn Rogers. 8vo, pp. 528, cloth 25s. (Simpkin.)

*SCIENTIFIC AMERICAN—An Illustrated Journal of Art, Science, and Mechanics. Vol. 12, from September 13, 1856, to September 5, 1857, folio (New York), pp. 418, half-bound, London, 18s.

*SILLIMAN (B. and B.)—The American Journal of Science and Arts. Conducted by Prosessor B. Silliman, B. Silliman, jun., and James D. Dana, in connexion with Professor Asa Gray, of Cambridge; Professor Louis Agassiz, of Cambridge; Dr. Wolcott Gibbs, of New York. Vol. XXIV. (whole number, 74); 2nd Series, No. 72, November 1857, with Four Plates. 8vo, pp. 149, sewed, 5s.

WEALE'S Builder's and Contractor's Price-Book for 1858: containing the latest Prices for Work in all Branches of the Building Trade, &c. &c. 3rd edit., 12mo, pp. 286, cloth, 4s. (Weale.)

WEIR (H. F.)—Land Measuring Tables, showing the Area in Acres, Roods, Poles, and Hundred Parts of a Pole of any Survey, Field, or Portion of Land measured by the Chain. By H. F. Weir. 12mo. (Glasgow) pp. 76, cloth, 2s. 6d. (Hall.)

---

* American Works.

ON SOME OF THE RECENT BOILER EXPLOSIONS.

The frequency of boiler explosions, which of late have been attended with considerable loss of life, demands the serious attention of the Government, as to the necessity for the appointment of Inspectors of Steam Machinery, whose duty it shall be periodically, but at brief intervals, to inspect and report upon the condition of steam-boilers and machinery.

We are adverse to Government interference with the management of private property generally; but the disgraceful and dangerous condition in which proprietors of steam power allow their boilers to be worked calls for the prompt interference of the strong arm of the law to prevent the recurrence of those frightful slaughters which have recently taken place.

Unfortunately, Coroners' juries are, from their constitution and local connections, generally but ill-suited tribunals for dealing with cases of this description; and we have on too many occasions observed the influences which have been brought to bear to prevent the proper and sufficiently strong expression of feeling being recorded against offending parties; and we fear it would be exceedingly difficult to obtain a verdict of manslaughter against a negligent millowner or proprietor of steam power, however apparent, gross, and criminal negligence might really attach to such persons; but if some miserably underpaid and incompetent engine-driver has the misfortune to sacrifice the lives of his fellow workmen from his ignorance, inexperience, or want of caution, the chances are many of such a verdict against him.

Is it not disgraceful, that wealthy millowners, manufacturers, and proprietors of steam power should, for the sake of so-called economy, employ ill-paid and incompetent persons in positions whereby often the lives of hundreds of persons are endangered by such accidents, and yet escape scathlessly an official investigation by a tribunal bound by the law of the land to do justice, and express their conviction of the punishment which should be awarded to such persons?

Instance the case of the recent explosion at Huddersfield; can anything be clearer than where the blame should rest?

It is only necessary here to refer to the brief account of the accident which we have already given, and to give the following extract from the "Leeds Mercury," of the report made to the public meeting held for the purpose of administering to the wants of the living sufferers by this melancholy accident—to show the extent of suffering which it has occasioned.

The Committee brought a report, which embraced all the cases of the sufferers, excepting two, Joseph Lum, the mechanic, and Henry Wrigley, of Brighouse. The latter, we believe, is very slightly injured; but the family of Lum is, we have privately learned, in very poor circumstances, a widow being left with three young children by Lum's first wife. They are residing at Ripponden. The Committee are doubtless only waiting to obtain satisfactory information on these points to relieve those who are left without husband and father, suffering from the loss of one, the mode of whose death formed one of the most terrible incidents in the fearful tragedy. We have thrown the report of the Committee into the following form for the sake of brevity and clearness:—

1. Jesse Firth, 35, engineer, Aspley, widow and three children, 15, 13, and 3 years old; a girl, 13, with arm paralysed. Not a penny in the house.
2. Elizabeth Hampshire, 20, Aldmondbury, widow, and son a weaver. Very poor, but receiving £2 from a funeral brief.
3. Mary Ann Garlick, 19, Jowitt's-buildings, Castlegate, father, mother, and two children; father in work, but in very delicate health. In a most destitute state.
4 and 5. Ellen and Hannah Lord, Lascelles Hall, Kirkheaton, father, mother, six children: nearly all young. Clothes worn by the family all borrowed. Only 3d. in the house, given to the father when coming from the funeral.
6. Lavinia Crowther, 17, Dock-street, father, mother, four children, 15, 9, 6, 4; father ill in bed. Money borrowed for the funeral; in very indigent circumstances.
7. Hannah Mossley, Aldmondbury, father and four children; father naturalist and bird stuffer.
8. Sarah Ann Stott, father, mother, and six children. Father and four children, employed at the factory now stopped by the explosion.
9. Joseph Butler, 13, survivor, no information; left the Infirmary; his injuries very slight. Decent poor people.
10. Mary Fletcher, 18, Aspley, father, mother, four children; one child, 11, unable to walk. The girl in two clubs; from one £2 9s. 6d. from the other £5; £7 9s. 6d. has been received.
11. Hannah Umpleby, 15, Almondbury, father and four children; one at the Infirmary. Father a tailor; all the family out of work. £2 received from funeral brief.
12. Louisa Umbleby, 19, dangerously ill from her injuries.
13. Emma Cliffe, 14, Old Post-office yard, father and mother and two daughters: one had a narrow escape. Father shoemaker; family very poor.
14. Joseph Lum, 34, Ripponden, widow and three children by a former wife. In necessitous circumstances.
15. J. Donaldson, Cross Church-street, large family; father and son slightly hurt. Still employed by Mr. Kaye.
16. — Donaldson, jun.
17. Henry Wrigley, Brighouse, slightly injured.
18. Benjamin Butterworth, New Ground, Damside, wife and one child. A little money saved.
19. Benjamin J. Shaw, Crosland Moor, wife and three children.
20. Solomon Widdop, Colne-road, very slightly injured.
21. Samuel, Ramsden, very slightly injured.
22. John Beaumont, very slightly injured.
23. — Oxley, very slightly injured.

From the "Manchester Examiner," of November 25th, we make the following extract:—

The Boiler Explosion at Huddersfield. Twelve Lives Lost.—(*From our Correspondent.*)—A number of men recommenced searching in the ruins at Kaye's cotton mill, Upper Aspley, yesterday morning, and about half-past eleven o'clock they found the missing bodies,—those of Jesse Firth, the engineer, and Emma Cliff, of Castlegate,—together, under a mass of bricks and stones, not far from where Firth was said to have been standing at the time of the explosion. This makes the number of dead, found on and around the premises, ten. Of the five persons injured, and removed to the infirmary, two died during the night, Elizabeth Hampshire, of Almondbury, and Mary Ann Garlick, of Castlegate. Two others in the Infirmary are scarcely expected to recover. The boiler, which was of 24 H.P., was manufactured about twelve months since by Messrs. Gledhill, Mitchell, and Armitage, boiler makers, Bradley Mills. When first put down, a new smoke-burning apparatus was applied, but not being found to answer, the machinery had to be altered, and legal proceedings followed with the proprietor of the smoke-burning apparatus. The matter in dispute, however, after being referred to arbitration, was privately arranged. It appears that the new engine which had been coupled that morning, not starting punctually, a number of the working girls came down to see the reason, and some to warm themselves, and they were standing near the engine fire at the time of the explosion. One of the men engaged in moving the fly-wheel dropped down into a recess under the floor, and thus miraculously escaped. Another man was blown into the goit, and at once brought one of the dead bodies out of the water.

For the sake of putting this case fairly before the readers of The Artizan, and with a view of making some further remarks upon it, we give the following somewhat lengthy extract from the "Manchester Guardian," of December 1st, and propose to conclude, for the present, with a few observations upon the evidence and the verdict of the jury.

Yesterday morning the adjourned inquest on the body of Joseph Lum, aged 34, mechanic, of Ripponden, who was killed by the explosion of a steam boiler, on the premises of Mr. C. G. Kaye, Upper Aspley, Huddersfield (by which twelve persons lost their lives on Monday week), was held in the Huddersfield Guildhall, before Mr. G. Dyson, coroner. After evidence had been given as to the finding and identification of the bodies—

Robert Gledhill, of the firm of Gledhill, Mitchell, and Armitage, Leeds Road, Huddersfield, stated that the boiler was refitted at their works seven months ago. It was a Cornish boiler, 21 ft. long, 5 ft. in diameter, with a fire-box 4 ft. 6 in. long and 2 ft. 11 in. in diameter, tapering off to 2 ft. 8 in. The sides of the boiler was 3-8ths in. iron, the ends ½ in. iron. The bottom of the fire-box was 9-16 in. thick, the top 7-16 in. thick. The fore end of the boiler was fastened with three gusset stays, two of them being fastened to the outer shell, and one from the flue to the end of the boiler. There was only one gusset stay rivetted to the outer shell at the other end. The boiler was fitted with a stop-valve 4 in diameter; a glass water-gauge at the front of the boiler; a common pillar and float water-gauge on the top of the boiler; an outlet pipe to warm the mill, ¾ in. diameter; a 1½ in. pipe to the force pump; a safety-valve, 4 in. in diameter, which was placed 4 ft. from the centre of the refitted boiler. The safety-valve had a lever 2 ft. 8 in. long, with a weight which allowed the safety-valve to rise at a pressure of 40 lbs. to the square inch. There was a Ludlam's steam-gauge at the end of the boiler. There was another boiler, and the safety-valve was fitted not in the usual place, but so as to act for both boilers, by Mr. Kaye's orders, contrary to witness's advice. Witness wanted to put a safety-valve on each boiler, and said the other way was not a safe one. Mr. Kaye remarked that they used only one boiler at once, and he would not allow the valve to be put on as witness advised. Witness connected the safety-valve and the stop-pipe, a thing he never did before or since. He told Mr. Kaye it was not safe, but did not remember the exact words. He told Mr. Kaye if the stop-pipe was shut, the safety-valve would be dangerous, but did not remember if he said it would not act. Before they took the boiler to Mr. Kaye's it was tried at witness's works by hydraulic pressure, and stood a pressure of 183 lbs. to the square inch. It would stand a steam pressure of from 40 to 60 lbs. to the square inch. [The valve being brought into court], Witness said the stop-valve was shut; it could not be shut by accident, but might have been shut after the explosion.—Cross-examined by Mr. Learoyd: This conversation took place two years ago, when the boiler was first laid down. The boiler was refitted in consequence of the construction of a square fire-box for a smoke-consuming apparatus, which prevented some of the rivets being properly tightened; and when it was refitted, after alteration of the fire-box, it was fitted up as before, without anything being said to Mr. Kaye of its being dangerous. Mr. Kaye might have said, "If you can make one safety-valve do for both boilers, do so."

Mr. Joseph Hopkinson, jun., engineer, stated that he had seen the boiler three weeks ago, and he did not see a pressure gauge. The fireman said he did not know what the pressure was. He (witness) had then said the fire-box was too large, and of a dangerous construction for high-pressure steam. Shortly after the explosion he examined the boiler. There was no deficiency of water. The fire-box had collapsed on the under side, as there were no stays left fastened to it, while there were two stays left on the crown of the fire-box. After explaining the make of the boiler, he said the safety-valve had no connection with the boiler; the only opening for steam was through the stop-valve. The stop-valve was *screwed down*, thus preventing egress of steam to the safety-valve; and there was no pressure of steam on the safety-valve. He found the stop-valve himself the next morning screwed down. The extent of the pressure of steam on the boiler could not be known, as there was no steam-gauge. He found a new valve, of a sliding construction, for the stoppage of the engine. This was open, and let the steam into the valve (or steam) chest. This condensed steam had to be got rid of before the engine was started, and to let it out a tap was fixed into the bottom of the steam-chest. The mechanic put that tap in during the dinner hour. When the workman was engaged in drilling the steam-chest to put the tap in, the sliding-valve being open, the steam would come out as soon as the point of the drill penetrated the chest, and would prevent the man from working. The only way to prevent this escape of steam was to close the stop-valve at the top of the boiler, and thus enable the workman to proceed. This stop-valve screwed down would cut off communication between the boiler and the safety-valve, and would confine the whole of the steam in the boiler during the dinner hour. When the engine had to start, the fireman, looking at the safety-valve, and not seeing it blow off (which it could not do for the safety-valve being screwed down), would fire up to get more steam; this would increase the pressure, and burst the boiler. The cause of the explosion was the stop-valve being screwed down to enable the workman to insert the tap into the valve (steam) chest. From the appearances he had seen, he considered there was a pressure of 75 lbs. to 100 lbs. to the square inch at the time of the explosion. Had the safety-valve been in direct communication with the boiler the explosion would not have taken place. Had the party in charge of the boiler had an ordinary pressure-gauge to it, the danger would have been shown to him; but as neither of these conditions existed, the explosion occurred. In cross-examination, the witness stated that the fireman ought to have had tools to work with. He had found masters refusing to fix gauges, &c., up, because of the expense. In Lancashire, scarcely a boiler was without a gauge; in Yorkshire, they were not common; in Newcastle-upon Tyne, and that district, they were scarcely ever met with.

William Fairbairn, Esq., C.E., F.R.S., of Manchester, stated that he had examined the boiler and its adjuncts. He described the formation of the boiler, and remarked that it was weak at the ends; but the explosion had not taken place from that cause: if it had been of double strength the explosion would have taken place, in consequence of the faulty principle of its construction. The construction of the stop-valve was such that when it was closed the communication was cut off, both to safety-valve and engine, from the boiler. This valve being closed, and enough steam generated, it was impossible for there to be any other result than an explosion. There was no indication of a deficiency

of water, and in his opinion the boiler burst first—from its malconstruction in the position of the safety-valve introduced for its preservation; second, from the negligence or ignorance of the working engineer (or other person) in closing the steam-valve on the top of the boiler, whereby the communication between the safety-valve and its interior was effectually closed. The stop-valve could be opened or closed at pleasure, and the other valve (the sliding-valve spoken of previously) being out of repair, the stop-valve was closed when the engine was stopped, and forgotten. The safety-valve was 3¾ in. in diameter, and was sufficient for the safety of the boiler, if it could have opened. His impression was that the flue collapsed first, and then the boiler went. He impressed on those present the absolute necessity of having competent persons to take charge of steam engines, and showed the necessity of having periodical inspection of boilers, as was the case in Manchester and Lancashire generally, by means of an association. In cross-examination he said, if the steam had free access to the safety-valve, one safety-valve would do for the two boilers; but it was essential that there should be a stop-valve, if one boiler was to work while the other was running. He strongly advised that safety-valves should be at the top of the boiler, and unconnected with anything else.

After the evidence of some mechanics, who had been working at the place, one of whom said had he known that the stop-valve was closed he should have opened it, or left the premises, Mr. Kaye, the owner, said he had ordered a steam gauge in June, and repeatedly urged its being fitted, which had not been done. He denied the truth of Mr. Gledhill's statement.

The Coroner said the cause appeared to be clearly pointed out in the report of Mr. Fairbairn, which was borne out by the very able report of Mr. Hopkinson. There could be a criminal charge only against the person who shut the valve, and there was no evidence as to who that person was.

The jury were absent two hours. Their verdict was "Died from the explosion of a steam boiler, resulting from the stop-valve being closed; but who closed it there is no evidence to show." The jury reprobated those concerned for the boiler being left without a pressure-gauge, and considered those blameable who did not fix it when it was ordered. They strongly condemned this combination of stop and safety valve; censured the engineer who applied, and the proprietor who permitted it; expressed strong disapprobation of the proprietor placing the engine in the care of a person who neither from training nor skill was qualified to undertake such an onerous duty; and, finally recommended the formation in that district of a boiler inspection association.

It will be seen from the above extracts that this investigation discloses a disgraceful indifference to the safety of those, who, whilst following their daily calling in earning their daily bread, trust for their safety to those whose first care and undoubted duty it is to provide to the utmost of their power, and to the extent of their judgment and their money ability, for the perfect security of their lives: and the employer of human labour who does not, should be visited with that punishment which such criminal neglect deserves.

The observations of the jury, after delivering their verdict, clearly show their feelings, and express their opinion with respect to the conduct of "*those concerned;*" and useful as their final recommendation might be, if properly carried out, it must not be forgotten, that without being invested with *compulsory powers of inspection* and authority to enforce *by law*, the adoption of what is absolutely requisite and necessary to make provisions for the perfect safety of steam-boilers, such a local operation would practically be next to useless.

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]

To the Editor of The Artizan.

THE RESISTANCE OF STEAM VESSELS.

Sir,—Your October Number contains an article written by me, with a view "to assist in vindicating mechanical principles from the flippant deductions of pretentious ignorance," which certainly appears to have added "bewilderment" to the confused notions of his subject entertained by the gentleman against whom its arguments were directed, or he would never have penned a reply, which, in every rational sentence, enables me to enforce one or other of the pointed charges I there advanced against him, and in great measure consists of a contemptible display of classical slang, hack quotations, and irrelevant nonsense.

"G. J. Y." commences with a quibble; and to a part of my distinctive statement between resistance and power: "Resistance is an aggregate of pressures, equivalent to a single pressure," he objects, "Is not every single pressure of the aggregate a resistance?" In reply, What is a single pressure but the aggregate of a number of pressures into which we might suppose the single pressure divided; singleness depending only on the employed unit which for my purpose it was unnecessary to define. To another part: "Power is an aggregate of pressures, respectively multiplied by spaces through which resisting pressures have been overcome, and is equivalent to a single mean pressure multiplied by the sum of the described spaces," he objects: "Power is simply a pressure operating against an opposing pressure, motion being produced by the one pressure being greater than the other; the quantity of motion being proportionate to the difference of the two pressures." In reply, divested of verbiage, his definition is simply, power is pressure, and is not the practical sense in which "power" is understood, even by "G. J. Y." himself. Notice his proposition, p. 137: "Let a force be exerted through a given space and ascertain the power expended, then, by quadrupling the force and doubling the space, it will be found that an expenditure of eight times the power will result." This he calls a "sheer truism." "Who doubts it?" and terms it "the condensed reasoning of all the cube theorists;" and hence, on his own statement, a direct negative to his assertion of the "almost universal recognition" of an authority who defines power to be some force tending to produce motion "*whether it does actually produce it or not.*" In his last paper, "G. J. Y.," finds it convenient to adopt this authority, forgetting that the last case of the clause in italics, affords a striking instance of that neglect of time which he deprecates; but the whole I refute by the earlier and more pertinent testimony of John Smeaton, who, in 1759, wrote as follows: "The word power, as used in practical mechanics, I apprehend to signify the exertion of strength, gravitation, impulse or pressure, so as to produce motion: and by means of strength, gravitation, impulse or pressure compounded with motion, to be capable of producing an effect: and that no effect is properly mechanical, but what requires such a kind of power to produce it. The raising of a weight to the height which it can be raised in a given time (as he explains *with equable motion*), is the most proper measure of power: or, in other words, if the weight raised is multiplied by the height to which it can be raised in a given time, the product is the measure of the power raising it; and, consequently, all those powers are equal whose product made by such multiplication, are equal: for if a power can raise twice the weight to the same height or the same weight to twice the height that another power can, the first power is double the second."

Again, from his "experimental examination of the quantity and proportion of mechanic power (this he defines to have the same meaning as 'power') necessary to be employed in giving different degrees of velocity to heavy bodies from a state of rest:"—"In trying experiments upon the total effects of bodies in motion, it appears that when a body is put in motion, by whatever cause, the impression it will make upon a uniformly resisting medium, or upon a uniformly yielding substance, will be as the mass of matter of the moving body multiplied by the square of the velocity." And after his simple and conclusive illustration of a man rolling an iron ball, he sums up:—"It, therefore, directly follows, conformably to what has been deduced from experiment, that the mechanical power that must of necessity be employed in giving different degrees of velocity to the same body, must be as the square of the velocity." Water forms no exception to this rule, and accordingly we find him explicitly stating, as the result of his carefully-conducted experiments on water-wheels:—"When the velocity of water is doubled, the adjutage or opening of the sluice remaining the same, the effect is eight times—that is, not as the square, but as the cube of the velocity" (for the obvious reason that the mass in the second case is doubled also). The following slightly-varied form of this proposition is as necessarily true:—If water be displaced by a body moved with a given velocity, the power in the displaced water, in a given time, will be eight times the power in the water displaced in the same time by the same body, when moved with half that velocity. Contrast this with "G. J. Y.'s" statement, page 40:—"Many persons, some years ago, finding that an increase of speed required an increase of H.P. considerably beyond what the square of the velocity indicated, empirically jumped at once to the cube." I leave your readers to consider whether "G. J. Y." has not "empirically jumped" at his conclusion; and they may further consider the profound dynamical and critical ability evinced by the question: "Who ever heard of the mass of a particle before?" On what principle did "G. J. Y." manage to assume that "a congeries of particles" could weigh 33,000 lbs.? Does not that "congeries" possess mass? and will not any particle of the "congeries," however small, have some mass also?

Smeaton's statement I introduced as the simplest form of the *principle of vis viva*, now so fully developed and applied to the treatment of all questions involving expenditure of power. Thus, referring to the "Encyclopædia Britannica," *newest* edition, we find the following:—"On the subject of applied mechanics, the following are some of the most recent and best authorities:—Poncelet, 'Mecanique Industrielle;' Morin, 'Notions Fondamentales de Mecanique;' Moseley, 'Mechanics of Engineering and Architecture;' Whewell, 'Mechanics of Engineering.'" The fourth of these I have not by me; instead, I will quote another known work, Weisbach's "Mechanics of Engineering and Machinery." Note their opinions! Those of M. Poncelet and Professor Moseley, for brevity, I indicate by a quotation from the latter: "In no respect have the labours of the illustrious President of the Academy of Sciences more contributed to the development of the theory of machines than in the application which he has so successfully made to it of the '*principle of vis viva.*'" M. Morin, page 96, states: "This principle has received the name of the *principle of vis viva*, and its generalisation serves as a basis to all applied mechanics." Professor Weisbach, page 48, states, in reference to the *principle of vis viva*: "And, hereafter, the mechanical work which a moved mass acquires may be put equal to half the *vis viva* of the same." This principle, "G. J. Y." informs us, he repudiates with contempt; while every sentence that he has penned in reference to it betrays thoroughly confused notions, if not utter ignorance, of what he is writing about! To establish this will be the best way of enabling your readers to estimate the precise value of *his* contempt.

In regard to the sense in which the term *vis viva* is used in practical mechanics, want of space will prevent my making long extracts. I simply state that all the authors I have quoted pointedly affirm that no occult or metaphysical idea whatever is attached to those words: they are simply used to denote the product of the mass by the square of the velocity; and the mechanical idea involved in the *principle of vis viva*, as the capability of a moving mass to perform work is measured by half the product of its mass by the square of its velocity; or, conversely, to communicate motion to a mass, work to the extent of half the product of the mass by the square of its velocity must be expended upon it. This, though not in exactly the same words, is precisely the practical statement of the question made by Smeaton; and its universal recognition is a convincing proof of the sagacity of the clear-headed "English Mechanic," who also wrote: "Without taking in the collateral circumstances both of time and space, the terms quantity of motion, momentum, and force of bodies in motion, are absolutely indefinite; and that they cannot be so easily, distinctly, and fundamentally compared as by having recourse to the common measure, viz., mechanic power." Again, so far from the *principle of vis viva* being in contradiction to the principle "that forces are proportional to the velocities generated by them in equal times," the latter is stated by the authors I have quoted to be a universally admitted fundamental axiom; and, I add, a necessary step to their further clear and definite perception of the difference between a force and the effect of the action of that force upon a free mass.

The *mechanic power, half the vis viva*, or *accumulated work* of a moving body is not a force! These are but different expressions for the *effect* of forces, which, during longer or shorter times, have acted upon the body in communicating velocity. They express the *mechanical effect* of those forces; and its

measure is the capability of the body to perform work—that is to say, to overcome resisting forces through space, independent of the time in which this action is accomplished. Mechanical effect has for its very basis the principle that it can neither be created nor annihilated by any human agency. When once developed, from whatever source, and impressed upon a mass, we must be able to account for it, either in work actually performed or by some equivalent physical effect. Now, part of the work may be expended in altering the structure of the mass itself; in a like change on resisting masses, accompanied by change of temperature in those masses; and, in many cases, it is the latter effect alone; and we are thus led to the considerations upon which the comparatively recent science of thermo-dynamics is founded.

Sir Humphrey Davy's simple experiment of melting ice by rubbing together two pieces under the exhausted receiver of an air-pump, indicated that some relation existed between the work expended and heat; this latter being the only element involved in the altered condition of the substance, and the work expended, the direct cause of that alteration. Dr. Joule, not only by direct experiment, but by collateral evidence from almost every branch of physical science, established their exact relation: and in this country, by his labours, and those of Professors Thomson and Rankine, it is an admitted scientific fact, that a "unit of heat" (the quantity that will raise 1 lb. of water by 1 Fahrenheit degree) and the mechanical effect equivalent to the performance of 772 ft.-lbs. of work, are strictly convertible terms. Let me illustrate this convertibility by a simple case. Suppose, with an air-gun, we shoot a lead ball directly upwards (neglecting friction in the gun, and the resistance of the air to the motion of the ball); when at its highest point, let it be caught and prevented from returning: with exactly the same velocity let two other similar balls be shot horizontally, one into water, and the other against a practically hard, immoveable block. By the principles of *thermo-dynamics*, in each of the three cases during the expansion of the condensed air, a quantity of heat, strictly equivalent to the mechanical effect of the force which has communicated velocity to the ball, disappears from the expanding air.

In the first case the ball ascends against the constant force of gravity with a uniformly retarded velocity; and when at the highest, work equal to the weight of the ball into its vertical ascent has been performed, and could be made available for the exact reproduction of the lost heat of the motive air when the ball had returned to its original level. In the second case the ball is exposed to a resistance varying as the square of its velocity, by which that velocity is rapidly destroyed, while the friction of the fluid particles speedily destroys the motions communicated to them in its passage. By induction from incontestable experiments, it is asserted that the ball and water, though they have lost all their communicated velocities, now contain, in addition to the heat due to their former temperatures, a quantity exactly equal to the lost heat of the motive air. In the third case we have the ball rebounding from the block as a shattered heated mass; and if we estimate the heat it contains, and the heat equivalent to work that may have been expended in altering its structure, as in the former cases, we arrive at the heat which has disappeared from the motive air. The obvious deduction from this is—that whenever *mechanical effect* (or *power, mechanical power, vis viva,* or *accumulated work*) *disappears, work to a definite amount is performed,* or *heat to a definite amount is developed,* it may be a combination of both effects, which, by "Joule's equivalent," we may then state in terms of either.

I will now refer to "G. J. Y.'s" objections, founded on impact, which, about eighty years ago, our old friend Smeaton handled with his usual ability. I need scarcely add that his remarks on the "mechanic power lost in collision" of course apply to the same thing under the name of *vis viva;* but as the principles of which I have presented a necessarily brief statement enable us to meet those objections in a more direct manner, I will simply inform "G. J. Y." that, should he examine his "non-elastic masses" after a violent collision, they will be likely to present to his notice the two following effects (which, in his wisdom, he may also repudiate with contempt):—They will be all thoroughly squashed and elevated in temperature; and, if he were capable of estimating the work necessary to restore them to their original condition, and the heat developed, this latter, multiplied by 772, together with the former, would precisely account for the lost *vis viva.* The work spent in altering the form of bodies introduces a difficulty which would have been avoided by taking a simpler substance—water. Suppose I lift a pail of water any height, and pour it into another volume, or even into another empty pail. After a few seconds, motion appears to be destroyed, and the water in the same state as at first; but, is the mechanical effect due to the action of the force of gravity upon its mass during its descent *annihilated?* Certainly not. If we employ proper means, it can be ascertained, that for every 772 units of the product, the weight of the water in pounds into its vertical descent in feet, or, what is the same thing, half the product of the mass, by the square of the velocity due to that descent, one unit of heat now exists in the water which did not exist formerly; and, as an experimental fact, this heat is precisely equivalent to the lost *vis viva.*

I will now meet some of the quotations advanced by "G. J. Y."

Barlow's statement that *vis viva* denotes the force or power of bodies in motion, is simply a misrepresentation. According to "G. J. Y.," with this author, the terms force, power, and pressure are synonymous. But *vis viva* is not a force, it is the effect of *force* upon *mass* when that mass yields to the action of said force, but is not the force itself. In the same way, neither "Leibnitz," nor any other competent authority, ever dreamt of measuring *moving force* by the squares of the velocities, when that term is employed in the sense in which it is used by the Encyclopædia Brittanica authority. The terms *vis motrix* and *vis viva* of Leibnitz, were applied to the effect of forces; "and in that sense," as admitted by "G. J. Y.," "doubtless the *vis viva* is as the square of the velocity." Again, Earnshaw is referred to; but "G. J. Y." takes care not to mention that in Chapter vii., by a rigid demonstration (in regard to which difference of opinion between two competent men *is not possible*), this author proves the very principle challenged. Thus (p. 155), "The principle above proved is of such extensive application in the various branches of mechanical philosophy:" and then goes on to explain in what manner to apply it in different cases; strange to say, among others, to the very case in which "G. J. Y." makes him assert that it is not true! My copy, second edition, 1839, *does not contain* "G. J. Y.'s" alleged quotation; but we have the following: "If the system move in a resisting medium the resistance must be reckoned as an impressed force;" which clearly proves that it *is* admitted as true by an author of whom "G. J. Y." evidently knows nothing. How, for example, could he write, "who ever heard of 'the mass of a particle' before," when, in the chapter just mentioned, consisting of a few pages, the symbol, m, repeatedly defined as the *mass of a particle,* occurs upwards of 150 times!

In regard to objections to the application of the principle, in cases where *vis viva,* in common language (though erroneously), is said to be *lost,* may I refer your readers to Dr. Lloyd's address at the latest meeting of the British Association, reported at p. 220 of The Artizan. As regards motions *of* or *in* fluids, the principle of *vis viva* is at once applicable; and in standard works on applied mechanics, is *the* principle employed in investigating those motions. As examples, I particularize the works of Poncelet, Morin, Weisbach; and one of the latest applications may be seen in Professor Moseley's investigation of the dynamical stability of floating bodies and rolling of ships.

I cannot intrude on your space with the remarks necessary for clearing up the mass of tangled statements with which "G. J. Y." has endeavoured to confuse the clear and obvious meaning of "what is meant by resistance varying as the square of the velocity." It may assist to exhibit his meaning, and Mr. Crouch's perception of my meaning, to recur once more to the "system" of the two weights; but in this, the likelihood of my laying fluxions before "G. J. Y." is very small indeed.

Sir John Herschell writes somewhere about the central thread of common sense on which the pearls of analytical research are strung. I reserve the pearls; but a sufficiency of cord will be devoted to "G. J. Y.'s" service.

In my objection "to planes drawn through water with certain constant velocities, the power to do this being supplied by constant falling weights," being compared "with the case of motion with a uniformly accelerated velocity," Mr. Crouch (much to my surprise) discovers that I deny that the work done by gravity on a weight descending through a given space is the same, whether that space be described with a uniform or with a uniformly accelerated motion. Nothing which I have written justifies such a conclusion. I have everywhere indicated and explicitly stated the very contrary; only I beg to observe, that the work spent on the resistance in the two cases may be very different. Thus, if a 20-lb. weight descends uniformly through 4 ft. in one second, the work that it must have expended on its resistance is $20 \times 4 = 80$ foot-pounds; but if a 20-lb. weight descends from rest, with a uniformly accelerated motion, through 4 ft. in the first second, the work expended by it on resistance is not 80 foot-pounds, but $80 - \frac{1}{2}\,\frac{20}{32}\,(8)^2 = 60$ foot-pounds (20 foot-pounds being the work accumulated in the descending weight, which, with the other 60, is the work of gravity, 80 foot-pounds, as before.) Hence, had the weights in the two cases been attached to planes drawn through water in the second in question, the first would have had a work of 80 foot-pounds expended upon it, and the second 60 foot-pounds only; but the mere supposition of such a case involves the glaring absurdity against which my objection was directed, and which I exposed in my succeeding remarks. I again exhibit it in another point of view. One weight draws up another with a uniformly accelerated velocity, and the work done (the difference of weights into the space described by either) is precisely equal to the work accumulated in the two moving masses; but notice, that here the mass is *constant!* On the other hand, should a descending weight draw a plane through water with a uniformly accelerated velocity, the mass at each instant is clearly *not constant;* instead of mass in the plane, we have the mass of the displaced water to consider, which varies at each instant with the velocity. Hence, in order that the velocity continue uniformly accelerated, mass at each instant must be added to the descending weight also. Uniformly accelerated velocity of the same weight drawing a plane through water is, therefore, a physical impossibility, and its supposition an absurdity.

Again, is it not evident, even to the perverted intelligence of "G. J. Y.," that the descending weight in one case being opposed by a constant mass, while in the other the opposing mass is "put" on the plane particle by particle, according to the velocity: the velocity of descent of the last, during the first part of the motion, will be *greater* than that acquired by the other weight in the same time; and that, since they both descend through the same space in one second, the velocity at the end is necessarily *less* than the velocity of the one raising the weight. Now, of the equal amount of work done by gravity on the descending weight on the two cases, less is accumulated in the weight moving with the least velocity; and, consequently, a greater amount expended on the resistance to its motion. Hence the assumptions that, in the varied motion of a plane through water, we can replace the plane by the weight raised by the motive weight, when falling the same distance in the same time, and that this weight "is the precise measure of the plane's resistance," are both *entirely false.*

In conclusion, I submit to the degradation of noticing his remarks concerning my small fraction. When he asks if I ever read Tredgold, he surely does not think that I advanced the small fraction as a discovery, which in a treatise by Barlow in that work (to the best of my recollection, in the case of the *Medea*), that author states as $\frac{1}{18}$; while by the analysis of a number of other vessels he deduces values from $\frac{1}{15}$ to $\frac{1}{24}$. From "G. J. Y.'s" remarks as to the state of my mind, I suppose he means that we are a pair of fools; but his politeness preventing him from stating his opinion openly, he proves it indirectly by mere "common sense," and some *special* arithmetic. Adopting, for argument, his figures, the *Rattler's* mid. area as a plane would have experienced a resistance of 42,000 lbs.; but, owing to the form of the ends, the resistance by experiment is only 6,000 lbs. I stated that the first term of the resistance is as "the immerged greatest transverse area multiplied by a small

fraction whose value depends on the form of the ends ...... multiplied by the square of the velocity." Now, what has been the effect of the ends in this case? Clearly to reduce the resistance from 42,000 lbs. to 6,000 lbs.; the resistance is now the same as it would be on a plane of $\frac{1}{7}$ the area. *Common stupidity* would have adopted this as the value of my small fraction; but we are informed, without further ceremony:

"So that 42,000 lbs. — 6,000 lbs., or $\frac{6}{7}$, is the value of Mr. Mansel's small fraction."

That 42,000 lbs. — 6,000 lbs. *is* $\frac{6}{7}$, will surprise most people; but I have to object, Is it my small fraction? In the first place, by Beaufoy's experimental results it would have come out $\frac{1}{10}$ nearly; but even then, being derived from a garbled equation, *it is not my small fraction.* Why is the frictional resistance, on which I insisted, not deducted from the 6,000 lbs.? I can, however, afford to accept "G. J. Y.'s" caricature, which yields $\frac{1}{7}$ as the arithmetical *development* of that which want of *principle* makes $\frac{6}{7}$.

Govan, Glasgow. ROBERT MANSEL.

STEAM-SHIP CAPABILITY.

To the Editor of The Artizan.

SIR,—"VIS VIVA" appears to be epidemic on the banks of the Clyde. I regret to perceive by your last Number that Mr. Arthur Löwentbal, of Greenock, is affected with that malady. This somewhat amazes me, because I have been wont to consider the iutellectual atmosphere of that locality peculiarly pure and invigorating. Mr. Löwenthal's case appears to be of a rather mild type; still it exhibits three alarming symptoms:—1st. An hallucination as to the meaning of words; 2nd. A prurient propensity to employ algebraic symbols absurdly; 3rd. An inordinate inclination to write—commonly called *cacoethes scribendi.**

The first symptom is very striking with regard to the word "*mass.*" I could understand a Scotchman's imagination being disturbed by the *Popish* use of the word; but why it should produce such an effect when used in *physics*, is to me inexplicable. But so it is.

The word is defined as follows in my Encyclopædia:—"MASS, a term applied to denote the whole quantity of matter of which a body is composed. *The mass will therefore be rightly estimated by the weight of the body without regard to its figure or magnitude.*"

This is wbat most people understand the word to mean; and how lamentable must be the effect of the *vis viva* mania when it is found to induce a man to write the following. Mr. Löwenthal states that "there are two principles in the inorganic world which constitute it, one active, called power; the other passive, called *mass.*" Mass a *principle!* But although these two principles are the constituents of the inorganic world, every minute particle, Mr. Löwenthal tells us, has *two powers* in it! Really *vis viva* has brought his perceptive powers into a pitiable plight! He proceeds—"I will exemplify a law, followed by every power, if acting upon a mass, only for the terrestrial gravity, a power known well enough by every one." What occult meaning this passage may have I cannot divine. It may be hinted, however, that what is known well enough by every one does not require algebraic exemplification. He says "the weight of this body may be P, its *mass* M!" What can he imagine its *mass* to be? He informs us tbat "the mass of a body is generally measured by the expression $\frac{P}{g}$". P, he has told us, means its *weight*. But though $\frac{P}{g}$ is generally used, he says "I prefer to measure a mass by the formula $M = \frac{P}{2g}$ as it will shorten my calculation, and at the same time is not incorrect." This wraps *mass* in still greater mystery. For $\frac{P}{g}$ is twice as much as $\frac{P}{2g}$ and yet *either* will do for its measure! The algebraic is a very startling paroxysm of the *vis viva* disease. Mr. Löwenthal thus describes its effect. He says, "thereby I get the formula H P = M V² in words"! *In words!* How many words do H and P stand for? how many do M and V² represent? The two latter, perhaps, mean *marvellous vis viva!*

For one moment let us seriously apply the touchstone of common-sense to this "formula $H\ P = M\ V^2$." The mass of a body is properly estimated by its weight; therefore we strike P off one side of the equation and M off the other, as being, not only *equal*, but *identical* quantities. The "formula" then becomes $H = V^2$. H represents the height through which a body falls during any given time, and V^2 the square of its terminal velocity. We will now test the formula by fact:—

Time.	Space fallen through in the second.	Terminal velocity.	Total space fallen through.
1st second	16 ft. 1 in.	32 ft. 2 in.	16 ft. 1 in.
2nd ,,	48 ft. 3 in.	64 ft. 4 in.	64 ft. 4 in.
3rd ,,	80 ft. 5 in.	96 ft. 6 in.	144 ft. 9 in.

This little table exhibits the action of gravity upon a falling body during three seconds. The formula is "$H = V^2$"! According to this precious production of an algebraic process, 32 ft. 2 in. squared equals 16 ft. 1 in.; 64 ft. 4 in. squared equal 64 ft. 4 in.; and 96 ft. 6 in. squared equals 144 ft. 9 in. A more conclusive proof of the virulence of the *vis viva* mania cannot be imagined.

His third symptom, above referred to, is manifest from the creditable expression of modesty with which he commences his communication: the fit was irresistible!—he probably struggled against it! I feel persuaded that when his malady subsides, and his intellect regains its healthy action, that he will perceive his befitting business to be to *read* and *study*. A good Mathematical Dictionary, "Chambers's Natural Philosophy," "Arnott's Elements of Physics," the article on *Force* in the "Oxford Encyclopædia," &c., &c., might be useful.

I should like to see the "good book" which is his authority for the following sentence. "The *vis viva* is exactly as much as the action which has been exercised in producing it; and, *on the contrary,* all the action produced by gravity in acting upon *a mass* is contained in it as its *vis viva.*" What is there antithetical in the first and last members of this sentence? The conjunction "or" might take place of "on the contrary," one would think. I will not venture to say that this emendation would make the sentence intelligible, or that the sentences which follow could be rendered intelligible by any process whatever; as they stand they are positive enigmas.

Mr. Mansel's theorem, Mr. Löwenthal informs us, "is the reason for which it is more convenient to measure a mass by half of that expression, which is more used for it, *because then the object called* VIS VIVA, *and the real* VIS VIVA, *are one and the same, and one is not half of the other.*" Assuredly if "the object called vis viva," and the "real *vis viva*" are "one and the same," it needed no ghost to tell us that one was not the half of the other. But why perplex us with an object "called *vis viva*" as contradistinguished from the veritable "*vis viva,*" if they are identical? Mr. Löwenthal's ailment, I am afraid, is not so mild after all.

He finds it easy to "put aside" my deductions from experimental philosophy in opposition to *vis viva*. No doubt of it; for he causes a *non-elastic* substance to consume *vis viva* by little *vibrations,* and a dense mass to *collapse!* One of the experiments I referred to he passes over, and the argument, illustrated by a diagram, he misunderstands. But the desert is not without an oasis after all. The following passage is indescribably cheering. He says "the moving forces are proportionate to the velocities they are able to produce." Bravo! The patient is convalescent! Why this is precisely what *vis viva* was introduced to disprove. G. J. Y.

* Our correspondent, "G. J. Y.," and our readers generally, will perceive that the apparent obscurity of Mr. Löwenthal's meaning is owing chiefly to typographical errors, which, through accident, remained uncorrected.—ED.

STEAM-SHIP CAPABILITY.

WE regret to find tbat in printing Mr. Löwenthal's letter in our December Number, a few errors have arisen. The following corrections are necessary to make it intelligible:—

1. Page 285, line 5, *for* "Thereby I get the formula $H\ P = M\ V^2$ in words. The action of gravity," *read*—"Thereby I get the formula $H\ P = M\ V^2$. In words: the action of gravity."
2. Line 47, *for* "smiths' work would last *ad infinitum,*" read—"*in infinitum.*"
3. Line 60, *for* "I beg to submit that 3 + 4 + 3 + 4 is not," *read*—"I beg to submit tbat (3 + 4) × (3 + 4)."
4. For the last 4 lines, *read*—"If the pressure of steam is greater than required for overcoming the resistances, the speed of the engine will increase, and at the same time the *vis viva* of all the moving parts, according to the quantity of work done, is superfluous. This is Mr. Mansel's theorem!"

SPEED OF THE "LEVIATHAN."

To the Editor of The Artizan.

SIR,—I observe in your Number for December, page 285, that the result of a rough calculation made by Mr. T. Moy to arrive at the speed to be realised by the *Leviathan,* is stated at "16 miles an hour with her *paddle-engines only,* and with her full power she will exceed 25 miles an hour;" which result appeared to me so monstrous, that I was induced to enter into a "rough" calculation to verify the same, as far as can be done with the few particulars that are generally known, as to the proportions of vessel and engines.

I now forward the speeds deduced by my rough calculations at varying drafts of water, that your readers may eventually test their accuracy; premising that the combined power of both paddle and screw engines working at a steam-pressure of 20 lbs. above the atmosphere is taken in all cases, viz.:—

Speed at 20 ft. draft = $18\frac{1}{2}$ geographical miles.
" 25 " = $16\frac{1}{2}$ " "
" 30 " = 15 " "

Greenwich, Dec. 16, 1857. I am, Sir, &c., W. B.

NOTES AND NOVELTIES.

MARINE ENGINEERING, SHIPBUILDING, &c.

A VISIT TO THE LIVERPOOL SHIP YARDS.—When in Liverpool for the purpose of visiting the new American mail steamer *Adriatic,* belonging to the Collins' line, we took advantage of the opportunity thus afforded of visiting some of the shipbuilding yards on the Mersey, and, amidst the depression which has prevaded all commercial operations for some time past, we found considerable activity amongst the shipbuilders on both sides of the river; the tonnage in course of building being about 11,000 tons at Liverpool, and about 5,000 tons at Birkenhead.

Mr. Laird bas one large iron ship and a number of small vessels on the stocks. A small wooden vessel is building at Tranmere Pool. Messrs. Clover and Royal have in frame a small wooden sbip. The Canada Works have a large iron ship in frame; and it is anticipated that Mr. Laird will shortly commence two of the new Holyhead and Kingstown despatch steamers, which are to surpass everything afloat for speed.

It is also expected that Messrs. Vernon and Son will shortly have an extensive order for iron barges and steam tugs, to be constructed for the navigation of the Indian rivers.

Messrs. Roydon and Son have contracts for two large clipper ships for the Australian and China trade, the larger of which, of 10,150 tons (B.M.), is partly in frame; the other, whicb may be about 900 tons (B.M.), which was but recently laid down. Mr. J. Steel has a ship of 800 tons register, in-

tended for the Indian trade, ready for launching. Messrs. T. and R. Clarke have a barque of about 500 tons measurement ready for launching. Messrs. Chaloner and Co. have a barque of 350 tons (B.M.) ready for launching, and have just laid down the keel of another of about 800 tons. These make a pretty good show of wooden ships of high class.

Mr. J. Jones has a ship of 1,450 tons, which is just being plated up; also, an iron screw steamer, 1,000 tons (B. M.), with engines of 270 H.P. She is a remarkably fine model, and is, we believe, intended for the Mediterranean. He has also a number of iron barges in course of construction.

Mr. W. Miller has an iron ship of 1,350 tons (B.M.), well forward; she is intended for the Calcutta trade. Messrs. Cato and Co. have a wooden ship 500 tons register, in frame; but they are doing nothing in iron. Messrs. Evans and Co. have two small wooden ships in frame; and Messrs. Vernons, in addition to having a large iron ship nearly finished, have some smaller ones in hand, and others about to be commenced. On the whole, we thought that the Liverpool folks have nothing to complain of.

Rope, Chain Cable, and Anchor Making in the Port of Liverpool.—It is but a few months since Messrs. Bibby and Co. publicly tested some hempen ropes, the threads for which had been spun by machinery, and, indeed, the ropes had been made *entirely* by machinery, and the improvement of such a mode of manufacture was satisfactorily demonstrated by the high test which ropes made by them withstood.

Messrs. Cato, Miller, and Co., iron ship builders, finding that business slack, have turned their attention to the manufacture of chain cables of superior quality, and to the forging of improved anchors, which are being extensively introduced, and are favourably spoken of. We are persuaded that if chain-cable makers would trust more to machinery and less to the judgment and skill of their workmen, more uniformly good and reliable chain cables would be the result.

The *Leviathan*, though not yet in her native element, has moved 104·6 ft. forward, and 96 ft. aft from her original position, proving her launch by the methods applied is feasible, and reducing the question simply to that of power and resistance. The method employed has been to give the first impetus or start by means of the hydraulic rams, and then compel her further progress by means of the strain upon her exercised by haulage on the river moorings. The anchors employed in this service had, one after the other, all given way, until Trotman's anchors were employed. One of these still holds, but in such doubtful ground as to make its tenure uncertain; whilst the other, owing to the hardness of the river bed, only sank a foot or so. On the 17th of December, a pressure equal to 2,000 tons was brought to bear. She moved, however, but 38 inches. The hydraulic pressure was worked to such a pitch, that the water was forced through the iron like a thin dew, until the whole cylinder was ripped up from end to end—with a noise like a dull underground explosion. The failure in the day's work was attributed to the fact of the gradient of the incline now reached by the ship being but 1 foot in 12, instead of 1 foot in 10. The efforts are, for a time, to be discontinued;—the period for their renewal is not named.

Floating College.—With the view of affording practical instruction to young men intended for the mercantile marine, it is proposed to establish a college on board a frigate-built screw, fitted up with the needful appliances. She is to be moved to different parts of the coast. The curriculum of study is to include navigation, marine engineering, gunnery, the higher mechanics, and collateral sciences.

Nearly all the marine engines of the Neapolitan Navy have been built at the model workshops of Pelrarsi, erected fifteen years ago. These factories are under the management of three officers of the Neapolitan Artillery—viz., Messrs. D'Agostinho, Corsi, and Afan de Rivera. 1,300 men are employed in the shops.

RAILWAYS.

Spain.—The Jativa to Valentia Railway is approaching completion—as far as Alcadia; between which point and Jativa passenger-trains will be run this month.

Communication with Guard.—Mr. W. Symons, of Dunster, proposes a simple plan of calling the Guards' attention, by a signal-cord passing along the train, and provides, by an expanding railing, for the safe progress of the latter from one end of the train to the other.

Tunnels near Lyons.—The difficulties encountered in the marly soils at the Lyons end of the Credo Tunnel have been surmounted. At the Surgaux Tunnel, slips are constantly occurring. The hill through which the tunnel is carried is sapped to the foundation —crevasses or chasms opening as the work progresses.

The General Roman Railway Company have contracted with the Crédit Mobilier Tuscana for their rolling stock.

Indian Railways.—The enormous resources of India, and the field they offer for railway business, fill us with astonishment when placed on paper. The Bombay, Baroda, and Central India Line passes through a country containing 62,616 square miles, tenanted by 7,150,000 souls; almost all of whom are employed in productive pursuits. 2,020,000 acres of this tract were under cotton cultivation, giving an average product of 141,402,030 lbs. This line alone—placing Bombay and Delhi in communication—would have sufficed to preclude the mutiny and occupation of the latter city; the first hostile demonstration would have been crushed. Such a line, Colonel French, the Chairman, stated would have been completed, but for the supineness and opposition of the Honourable East India Company.

The London and South Western Railway are about applying to Parliament for an Act to enable them to extend their line to Topsham, at an expense of £50,000.

On the Cornwall Railway, at Saltash Bridge, hydraulic presses have been used in lifting the span of the bridge. The west end was raised 3 ft. in two hours; the masonry being built up under it.

TELEGRAPH ENGINEERING.

On the 14th of November the *Elba*, bearing the electric cable, accompanied by the *Desperate* and *Blazer*, left Cape St. Elia. The process of paying-out then commenced, and was continued, without interruption, during the passage to Malta. Gozo was sighted in the morning of the 17th, and the same night the united exertions of telegraphists and sailors landed the cable safely on the coast of Malta. During the night of the 14th, and the whole of the 15th, the little squadron experienced severe weather, and the paying-out process was with difficulty regulated. All, however, went well, and the cable is now bedded, and a temporary office established at St. George's Bay. During the voyage, a constant communication was kept up with Cagliari, and the cable was tested every quarter of an hour. On landing, it was again tested, and its insulation found perfect. Messrs. Liffier and Tischelman made, during the voyage, a series of electrical experiments with the instruments of Messrs. Siemens and Haeske, of Berlin.

HARBOURS, DOCKS, CANALS.

The Suez Canal.—We have received the following intelligence respecting M. de Lesseps' movements:—On the 23rd November he was at Corfu, on his way to Constantinople. The sympathetic reception he met with in that town was enhanced by the circumstance of his father having been Governor of the Ionian Islands in 1814, for France. Mr. Young, the Lord High Commissioner of the Ionian Islands, gave a most hearty welcome to M. de Lesseps, who intended leaving for Athens by the Isthmus of Corinth, and was expected to arrive at Constantinople on the 3rd December. On the 28th November he appears to have been at Athens. We learn he was much struck with the general enthusiasm everywhere in favour of his grand enterprise. The French flag was hoisted on board Lloyd's steamer, which was to convey him to his port of destination. P.S.—A telegram has been since received announcing M. de Lesseps' safe arrival at Constantinople on the 14th December.

France.—The Council General of the Department of the Seine has passed a resolution in favour of the Suez Canal, recommending this enterprise to the solicitude of Government. The Department of the Seine, being in reality the capital of France, has caused great weight to be attached to the favourable result of its deliberations; and it seems that the promoters have every reason to be satisfied with the progress of their endeavours, which have hitherto been crowned with most signal success, seeing that this forms the seventieth favourable resolution passed in France.

The Suez Canal.—"The Constitutionnel" contains the following extract from their correspondent at Constantinople, dated 18th November:—"As to M. de Thouvenel, he continues to maintain the same reserve, until it is made clear that Rechid Pacha gives proofs of his goodwill towards France. An opportunity will shortly be afforded to him in the shape of the project of the Isthmus of Suez Canal. The Ambassador of France has sent an official note to the Porte on this subject; and as there exists no other opposition than that of Lord Stratford de Redcliffe's, it will be easy for the Turkish Government to give a satisfactory reply. It would be the means of arriving at the re-establishment of relations on the old footing, and to prove that the Turkish Government is not disposed to submit to the yoke of the English Ambassador. As may be conceived, Lord Stratford neglects nothing to prevent the Sultan's consent; he has always endeavoured to oppose it. Not that he disapproves of the project (*au fond*), but because it has not been brought forward by himself or under his own auspices. He attaches the more importance to his success, seeing that a failure might question his influence, which, by the way, has greatly lessened lately, but considerable silence has been preserved on this matter. He seems to attach much importance to outward appearances; and for some time past his ambition has been, not to do, but to affect to do everything himself, persuaded that such conduct would be sufficient to preserve, in his own country, the reputation he enjoys for being eminently qualified for a post which he persists in holding in spite of and against every body else. All the world hopes that Rechid Pacha, with his usual discernment and ability, will comprehend the necessity of seizing the present opportunity to put an end to a state of things which everyone truly deplores, and to show that deference to which the collective opinions of Europe is so eminently entitled. A council of ministers has already been summoned to deliberate on the official note from the French Ambassador. A Ministerial Assembly is shortly announced for the purpose of coming to a final decision on this interesting project. M. Ferd de Lesseps is daily expected here by the packet from Trieste."

Holland.—At the Royal Academy of Sciences at Amsterdam a very interesting meeting took place. It appears that it is a rule established by the State, that every member shall hold a discourse during the year. This time it fell to the turn of Mr. Conrad to do so, and this gentleman, who is a member of the international commission of the Suez Canal, naturally selected that subject for his lecture. His audience was more than usually numerous, on account of the public being, in the present instance, admitted to this scientific *réunion*.

The Works of the Sulina on the Danube.—According to the arrangements of the Privy Councillor and Water Engineer, M. Nabiling, the direction of the works for the deepening of the shallows of the so-called Argagni banks in the Sulina channel of the Danube, as well as the other works near Tultscha, has been given over to the architect, Richradt, of Coblenz. Another batch, composed of an overseer and thirty men, have lately left for Tultscha; and as Prussia has no conflicting interests in the fair navigation of the Danube, the works may be soon completed.

Docks and Tunnels.—At Bahia, in the Brazils, two works of great public importance are about to be carried out. A slip for ships of largest class, and a tunnel connecting the upper with the lower town. Mr. Vignoles is the engineer, who has charge of the latter work, was its original projector. Bahia contains 150,000 inhabitants.

A Submarine Tunnel between France and England is again talked of. The new project is from M. Thomé de Gamond. The English and French Governments have appointed commissions to examine its practicability.

BRIDGES.

Invention of Suspension Bridges by the Chinese Sixteen Hundred Years ago.—The most remarkable evidence of the mechanical science and skill of the Chinese at this early period is to be found in their suspended bridges, the invention of the Han dynasty. According to the concurrent testimony of their historical and geographical writers, Shan-leang, the Commander-in-Chief of the army under Kevutson, the first of the Hans, undertook and completed the formation of roads through the mountainous province of Shenise, to the West of the Capital. Hitherto its lofty hills and deep valleys had rendered communication difficult and circuitous. With a body of 100,000 labourers, he cut passages over the mountains, throwing the removed soil into the valleys, and where this was not sufficient to raise the road to the required height, he constructed bridges which rested on pillars or abutments; in other places he conceived and accomplished the daring project of suspending a bridge from one mountain to another across a deep chasm. These bridges which are called by the Chinese writers, very appropriately, flying bridges, and represented to be numerous at the present day, are sometimes so high that they cannot be traversed without alarm; one still existing in Shenise stretched 400 ft. from mountain to mountain over a chasm of 500 ft. Most of these flying-bridges are so wide, that four horsemen can ride on them abreast, and balustrades are placed on each side to protect travellers. It is by no means improbable (as Mr. Pauthier suggests) that as

the missionaries in China made known the fact more than a century and a half ago, that the Chinese had suspended bridges, and that many of them were of iron, the hint may have been taken from thence for similar constructions by European engineers.—*Thornton's History of England.*

The New Bridge over the Rhine.—The bridge between Strasburg and Kehl will consist of five arches. The three in the middle will have a span of 190 Badish feet, and will be of iron, according to the system of the Kinzing Bridge near Offenburg. The two exterior arches will have two iron turnstiles, which will allow a passage of 86 ft. to ships carrying masts. For obviating the difficulty of laying wooden posts in the moveable bed of the Rhine, tubes of cast iron will be used, which can be rammed in to the depth of from 40 to 50 ft. The new bridge will be exclusively used for the trains and passengers, for whom a trottoir will be made outside the railing. The floating bridge hitherto existing will be preserved for the traffic of the various roads leading to and from Strasburg.

MILITARY ENGINEERING.

Gunpowder.—A French Artillery Officer, General Piobert, has discovered a method of preventing the explosion of gunpowder when stored in magazines. It is effected by simply mingling coal dust with the powder. This mechanical admixture neutralises the explosive quality and reduces the powder to a simple combustible. An experiment on a large scale has tested the value of the invention. A magazine filled with the powder so prepared, was set on fire and it burnt like common coal; it was extinguished with ordinary fire engines. To restore the powder, it is simply sifted, when the gunpowder falls to the bottom, leaving the coal dust.

Gabions.—Two new descriptions of gabions have been recently offered for the adoption of the Queen's Service. Capt. Tyler's gabion is exceedingly simple, being composed of one sheet of galvanized iron, 6 by 4 feet. The edges of the sheet are wrapped together, and fastened with wire, and the gabion is thus completed. Sergeant-Major Jones's gabion is composed of bands of sheet-iron, about 4 inches in depth, on wooden pickets, the bands being fastened by two buttons fitting into corresponding holes.

AGRICULTURAL ENGINEERING.

Farm implements made on scientific principles are being daily added to. This, the oldest department of industry, is at last being worked out with this same view to economy and efficiency which has always characterised these processes, technically known as engineering work. The names of Tuxford, Clayton, and Shuttleworth, Hornsby, Garrett, Ransomes and Sims, with some others, are gradually acquiring as worthy a place in the world of industry as have already done those of Stephenson, Rennie, and Brunel.

Improved Method of Grinding Maise.—The growth and consumption of Indian corn is far greater than we in the Northern climes may imagine. The United States alone produce, annually, more than 200 millions of hectolitres, of which only 12 millions of hectolitres are exported, all the rest being used for the alimentation of men and animals. The hitherto mode of grinding maise into flour was very imperfect, and the difficulty for the cooking process and panification arose from the circumstance that the *resinous* and other improper substances were allowed to pass with the nutritious and wholesome. The new procedure is based on an accurate anatomical examination of the grain of maise (*Zea mais*), too lengthy to be dilated upon here. M. Betz-Penat has invented a procedure, by which the pellicle, the cotyledon, the resinous matter, and the vascular tissue (improper for man's food) can be separated from the fecula and the *matière cornée*, which alone are fit for perfect panification. Hitherto, the grain of maise was roasted (dried) before being ground; M. Betz-Penat, on the contrary, soaks it for half an hour in water, then he lets it drip dry for another half hour, when it is put in the mill. The French Journals say that the mill is now in operation.

GAS ENGINEERING.

Production of Gas.—A very interesting work on the history of the application of gas to illuminating purposes has been produced by Mr. H. Gerner, C.E., New York. Mr. G. desires to point out the superiority of olefiant to coal gas. In 1667, a Mr. Shirley first drew attention to a natural reservoir of gas in a coal field near Wigan. He traced the gas to its true source. The year 1726 witnessed further inquiry on the part of Dr. Hare. In 1768 an agent on Lord Lonsdale's estate proposed to light the town of Whitehaven; but the magistrates protested against the temerity. To Mr. Wm. Murdoch, a Cornish man, the erection of the first manufactory was due, and he first experimented in his own house and office. In 1798 he lighted Boulton and Watt's foundry; and in 1805 he erected an apparatus for lighting the largest cotton mills in the United Kingdom; the light equalling 2,000 mould candles of six to the lb. Mr. Gerner compares the relative merits of electric-hydro-carbon and peat, water, and wood gas.

Mr. Gerner inclines to the opinion that oil gas is preferable and superior to that distilled from coal, and explains that expense hitherto has alone prevented its general adoption. This difficulty has been overcome by Mr. Longbotham, who has succeeded in extracting from resin other matters of commercial value, at the same time obtaining an improved article for the manufacture of gas in the shape of an oleaginous residuum, that, reference being had to the other products, may be termed costless.

Mr. Haly has obtained provisional protection for a contrivance for diminishing the injurious and obnoxious effects produced in the burning of gas, especially when used as an illuminator. He closes the upper orifice of the chimney with a hollow lid, of a heat-resisting material, completely closed at the lid and sides, but ventilated at the bottom, where it projects at one or more places beyond the said orifice by apertures, which, in their aggregate area, should not be less than the area of the lower orifice of the said shade or chimney.

DOMESTIC AND SANATORY.

Smoke Nuisance.—A gentleman of the name of Wyld has suggested, in a letter to the "Times," the propriety of conducting smoke from domestic and factory fires through the sewers. This, he says, would free the atmosphere, and add to the value of the sewerage as a manure by fixing its ammonia.

The Victoria Sewer needs reconstruction, it would appear (at an expense of £6,000), from a point near Whitehall. The sum already expended is upwards of £60,000. Having been carried through a quicksand open to tidal influence, the difficulties encountered were of no mean order.

MISCELLANEOUS.

Statistics of the British Iron Manufacture.—In a recent pamphlet by Mr. Joseph Hall, the inventor of a method of making iron by one process, in place of two, is the following table, showing the quantity of iron produced in the year 1854, in the various districts of England. It will be observed that Glamorganshire approaches very near to Staffordshire, and that the quantity produced in Scotland and the north of England is becoming very considerable :—

Counties.	No. of works.	Furnaces erected.	Furnaces in blast.	Produce in tons.
England :				
Northumberland, Durham, and Yorkshire	37	106	80	348,444
Derbyshire	13	33	25	127,500
Lancashire and Cumberland	2	5	3	20,000
Staffordshire	72	203	166	847,600
Shropshire	13	34	28	124,800
Gloucestershire	4	7	5	21,990
Wales :				
Flintshire and Denbighshire	7	11	9	32,900
Glamorganshire anthracite district	14	35	21	750,000
Ditto, & Monmouthshire bituminous district	34	134	100	
Scotland :				
Ayrshire	9	41	30	249,600
Lanarkshire	13	88	72	46,000
Other counties	10	27	16	79,040
Total	228	724	555	3,069,874

Mr. Bessemer, it is said, has been joined by Messrs. Galloway, of Manchester, and are constructing extensive works in Sheffield for the purpose of introducing the manufacture of steel according to his patents.

Cast Iron for Architectural Purposes.—I have often wondered that cast-iron has not become the most frequently employed material for spires and lanterns of churches, for which feature it would have many advantages over stone;—it would exert less weight on the supporting tower, it would be less expensive and sooner raised, being cast in pieces, which could be taken up separately and rivetted together in their final position. Beautiful and aërial forms, composed of open and pierced work, might be produced in cast-iron, such as have never been exhibited in stone, of which latter material there need be no imitation; for general beauty and variety would be better secured by painting them a colour that would contrast with the stone below. The few instances in which cast-iron has been employed for these purposes in modern times, while they prove the advantages to be derived from its application, show also the great scope that remains for improvement in its mode of treatment and development of its capabilities; and if, with the mechanical means and knowledge of the present day, it were again brought into use, common sense would, I think, soon lead to its extensive adoption.—*Speech of S. Huggins, at Liverpool Architectural Society, as reported in "Building News."*

Coal Mining in Russia appears to be rapidly progressing. Mines in the western slopes of the Ural, opened in 1851, have increased their annual yield from 217 to 4,403 tons. On the eastern slope, the mines opened in 1853 have increased from 96 tons to 2,282 tons. The total yield during the last three years was 16,979. But a small portion of these were exported beyond the district, all being consumed in the factories there.

The extent of lines erected, or in progress, is 80,000 miles, divided as follows:—

Europe	37,900 miles.
United States	33,000 ,,
India	5,000 ,,
South America	1,500 ,,
Submarine	900 ,,
To this add—	
Atlantic Submarine	1,700 ,,
	80,000 ,,

Accident at the Mersey Steel and Iron Works, Dec. 10.—An accident of a very alarming nature, which, fortunately, was not attended by any loss of life, took place at the upper works of the Mersey Steel and Iron Company. The rim of one of the large fly-wheels suddenly broke, occasioned, no doubt, by the great velocity at which it was whirled. The wheel is between 30 and 40 tons weight, and runs at the rate of 100 revolutions per minute, at which speed it was probably going at the time of the accident. The heavy portion of the wheel flew about in all directions, breaking the large beam of the engine, and forcing numerous fragments through the roof, while some portions struck several of the men, who, in two or three instances, were very severely injured. The noise occasioned by the bursting of the steam-pipe, which is fed by nine funnel boilers, was heard all over the park, and occasioned great alarm, for in a short time several hundred people were at the scene of the accident. The engine, which is 150 H.P., is a complete wreck, and the stoppage will for some time cause at least 100 men to be thrown out of employment. At the time of the accident between 100 and 200 men were at work, and it appears marvellous that more persons were not injured. The works are so arranged that the other side of the premises—that portion devoted to making iron plates for shipbuilding purposes—can be carried on, although some of the machinery is connected. Mr. Clay, the manager, was early at the scene of the disaster, and rendered every assistance in his power. Beyond the mere accident, it is much to be regretted that it should have taken place at the present period of distress, as many more men will be added to the number of persons out of employment.—*Liverpool Mercury.*

NOTICES TO CORRESPONDENTS.

R. B., Liverpool.—We *have* heard of the project by Mr. J. Clare, Jun., and have inspected a model which we understood embodied his views. Mr. Scott Russell designed the *Great Eastern* steam-ship, and the paddle-engines and machinery were designed and constructed by him. The four cylinders are each 74 in. diameter; the diameter of the cylinders (two) of the *Adriatic* is 101 in., or 1 in. larger than the cylinders of the Cunard steamer *Persia*; but if you will take the trouble to refer to the index for 1856 and 1857, you will be able readily enough to find the information you require respecting the *Great Eastern*; and in the present Number you will find a notice of the *Adriatic*, with references to previous Numbers containing other particulars.

N. J.—The locomotive engines you refer to were constructed by the late firm of Stothert, Slaughter and Co., Bristol. Messrs. Sharp, Stewart and Co. are the builders employed by the firm you mention.

Q.—We should say that Mr. Joseph Beattie, the locomotive superintendent of the London and South-Western Railway Company, has done most in the way of constructing coal-burning locomotives; and we believe Mr. Benjamin Fothergill, of Manchester, has been for some time past conducting a series of experiments upon either the Lancashire and Yorkshire, or the South Yorkshire Railway.

G. E. B., Birmingham.—We are informed by Mr. Scott Russell, in reply to your inquiry, that the Papers on the Wave Principle, inquired for by you, are to be found in some of the Reports of the British Association of about twelve years back, and that they have not been separately published.

W. H. N., Isle of Dogs. — We are much obliged for your letters upon apparatus for "deep diving;" and when we have had an opportunity of communicating with the correspondents referred to, we will put you in communication with them.

R. J., Sonth Shields.—You should examine the List of Patents given at the end of each Number of THE ARTIZAN during the last two years, and make a list of such as you think bear upon the question, and we shall then be prepared to advise you upon the subject.

O.—We are unable to decide which is really the better arm of the two named by you, for we have never carried a revolver; nor have we yet taken advantage of the polite offer which one of the patentees you name made to us about four years ago, to go to his works and select any pistol we preferred, and might be willing to accept for our own use; but we have heard both Colonel Colt's and Adam's revolving pistols highly spoken of by competent judges of such weapons, and make no doubt they have each merits of their own.

T. P. R., Havannah.—The parties you refer to are Americans—not Englishmen. Inquire of Mr. Haswell, 6, Bowling Green, New York.

C. E., Valencia.—The rail and sleeper you describe was patented some time ago by a Mr. Seaton, and has, we believe, been tried on the North-Western Railway, and elsewhere; but with what success we are unable to state; nor can we furnish you with Mr. Seaton's address. The material you describe is known as Kamptulicon, and is composed of a mixture of cork shavings or cuttings ground up and incorporated with india rubber.

R., Glasgow.—Silver's four-ball governor is the only complete marine governor we have seen. If you will send us your address, Mr. Silver's agent in Glasgow shall forward you particulars.

De'L., Lisbon.—We happen to know to the contrary. Write to M. Dos Santoz, at the Portuguese Legation, in London; but it will be waste of postage and trouble, as we are quite satisfied that you are in error. In future, prepay your letters.

B.—The attempts to raise the Russian ships of war, which were sunk in Sebastopol harbour, have failed; and we believe that Mr. Gowan has entirely given up the attempt, in consequence of the Russian Government having objected to his blowing up, instead of raising the hulls. We do not know how much to believe of the flaming statement which was circulated respecting the powerful and extensive character of the machinery which Mr. Gowan took out with him to Sebastopol for the purpose.

NOTICE.

IN consequence of the length to which the Annual Address, and several Papers, Reports, &c., inserted in the present Number have extended, we have been compelled to omit entirely several important communications, and to omit part of Mr. Hughes's Paper on Girders, &c. Amongst the Papers which we have been compelled to omit, is one upon the Atlantic Telegraph Cable; another upon—What is Best Scrap Iron?

DIMENSIONS OF NEW STEAMER.

STEAMER "INDEPENDENCE."

Built for Captain E. Nye, under the superintendence of E. W. Smith, engineer. Hull by Samuel Sneden, New York; Engines by Morgan Iron Works, New York.

	ft.	ins.
Length on deck	140	0
Breadth of beam (molded)	26	0
Depth of hold at ditto	10	3
Tonnage custom house	250 Tons.	

DESCRIPTION.

Number of engines, two; kind of ditto, vertical beam; kind of boilers, return flued; diameter of cylinders, 32 in.; length of stroke, 8 ft.; diameter of wheel over boards, 27 ft.; length of boards, 7 ft. 6 in.; depth of ditto, 1 ft. 8 in.; number of ditto, twenty; number of boilers, two; length of ditto, 18 ft.; breadth of ditto, 7 ft. 6 in.; height of ditto, exclusive of steam drums, 7 ft. 9 in.; number of furnaces, two in each boiler; breadth of ditto, 3 ft. 2 in.; length of fire-bars. 5 ft.; number of lower tubes, four of 17 in., four of $16\frac{1}{4}$ in.; internal diameter of upper flues, 1 ft. 5 in.; length of ditto, 13 ft. 6 in.; diameter of chimney, 4 ft. 6 in.; height of ditto, 28 feet; boiler pressure in lbs. per square inch, 30 in.; cutting off (from commencement of stroke), one half; area of immersed section of vessel at trial, 210 ft.; combustion, natural draft; date of trial, October, 1857; draft, 9 ft.

Frames of white oak, 1 ft., molded, by 10 and 12 in., sided, and 2 ft. apart; number of bulkheads, two; masts, two; rig, schooner.

Intended service, Harbour of Valparaiso.

Remarks.—This steamer is designed for towing in the Harbour of Valparaiso. She is well suited for the purpose, having engines of great power proportionate to her hull; and the crank-pin of one engine is so fitted, that her engines can be worked independent of each other, when it is required to do so.

Bottom planking, bilges, and sides of white oak, 3 in.; ceiling of yellow pine, 4 in.; bilge strakes (five on each side), 6 in.; stringers, yellow pine, 6 × 26 in.; keelsons, 12 × 14 in.; deck beams, 10 × 12 in., 6 ft. between centre; knees of hacmatac, ledge, bosom, and hanging, at every beam; deck plank, white pine, 3 in.; bulwarks solid; frames, strapped with double and diagonal laid iron braces $3\cdot5 \times \frac{9}{16}$ in., one to each frame. No cabins on deck. One independent steam, fire, and bilge pump; keel, 13 × 13 in.; floors not filled in solid; anchors, 1,200, 1,020, and 300 lbs.; chains, two of 90 fathoms each, one 1 in. in diameter, one $\frac{7}{8}$ in. ditto.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 27th July, 1857.

2044. F. B. Anderson, 56, High-st., Gravesend, Kent—Mechanical slow match for submarine or mining operations.

Dated 15th August, 1857.

2174. G. T. Bousfield, Loughborough-park, Brixton—Preparation of dough.

Dated 18th September, 1857.

2417. J. M. Munro, jun., Bristol—Metal wheel-stock.

Dated 5th October, 1857.

2552. J. Coombe, Belfast—Machinery for hacking and preparing fibrous substances.

Dated 15th October, 1857.

2641. H. A. L. Negretti and J. W. Zambra, Hatton-garden—Producing graduated scales and other signs, letters, numerals, characters, and pictorial representations, upon porcelain and other ceramic and enamelled materials, which improvements are applicable to the graduated scales of meteorological and other philosophical instruments.

Dated 16th October, 1857.

2648. D. Guthrie and J. Vavasseur, New Park-st., Southwark—Machine for cutting, chipping, or rasping dye-woods or other similar fibrous substances, for the purpose of obtaining extracts.

Dated 19th October, 1857.

2676. R. Garvey, Asland, New York, U.S.—Apparatus for determining position and direction on land and sea.

Dated 20th October, 1857.

2684. C. Tooth and W. W. Wynne, Burton-on-Trent—Refrigerator.

Dated 21st October, 1857.

2686. R. Clark, Glasgow — Consumption or prevention of smoke.

Dated 22nd October, 1857.

2694. M. A. F. Mennons, 29, Rue de l'Abbaye-Montmartre, Department de la Seine, France—Machinery for the preparation of peat.

Dated 23rd October, 1857.

2704. W. H. H. Akerman, Bridgewater—Organs and similar musical instruments.

Dated 24th October, 1857.

2708. J. Thom and H. McNaught, Glasgow — Looms for weaving.

Dated 26th October, 1857.

2712. I. Jones, St. Helen's, Lancashire—Sheet glass.
2714. J. Horrocks, Manchester—Winding machines, bobbins, and shuttles for weaving.
2716. J. Ferrabee, Phœnix Iron Works, and C. Whitmore, Stroud — Machinery for carding, scribbling, and condensing fibrous substances.

Dated 27th October, 1857.

2718. W. Clarke, Laybourne-rd., Camden-town—Connecting and working breaks for railway carriages.
2720. T. Mottram, Rockingham-st., Sheffield—Knife handles.
2722. R. A. Margetson, Norwich—Communicating between guard and driver on railways.
2724. R. Urie, Paisley, and W. Sutherland, Penelope Works, Greenock—Manufacture of knitted and weft-netted warp fabrics.

Dated 28th October, 1857.

2726. H. J. Daniell, Donington-park, Derby—Communicating by signals between the pilot and steersman, and between other parts of vessels.
2728. J. E. F. Luedeke, Birmingham—Motive power engine.
2730. P. A. M. Maury, Paris—Cutting the pile of velvets.
2732. A. Bourgeois, 457, New Oxford-st.—Preparing liquor for tanning hides and skins.
2734. J. Sloper, Oxford-st.— Motive power for propelling ships, &c.
2736. W. Clark, 53, Chancery-la.—Manufacture of murexide.
2738. W. E. Newton, 66, Chacery-la.—Manufacture of sewing silk, twist, and different kinds of thread.
2740. J. Child, Loveday-st., and J. Child, Howard-st., Birmingham—Double-barrelled gun, with an elevated rifled tubular rib.
2742. J. Fraser, Glasgow—Manufacture of saltpetre.
2744. W. Greening, Lower Edmonton—Enamelling and ornamenting metals.

Dated 29th October, 1857.

2746. D. de la C. Gourley, Wilton-house, Regent's-park—Ambulance carriages.
2748. T. Cook, Old Kent-rd.—Machinery for cutting, framing, and packing wood matches.
2750. W. Padget, Poole — Earthenware pipes for drains and sewers.
2752. E. Smith, Carlisle-st.—Safety hook fastening.

Dated 30th October, 1857.

2754. J. Evans, Lower-rd., Islington—Affixing patterns and designs upon rollers and blocks used for imprinting.
2756. H. Charlesworth and W. Chapman, Huddersfield—Machinery for preparing fibrous substances to be spun.
2758. W. Shields, Salford—Machinery for etching, engraving, and cutting cylinders and other surfaces, to be used in printing and embossing.
2760. J. Davy and W. Bentley, Bradford, Yorkshire—Looms for weaving.
2762. T. S. Prideaux, 32, Charing-cross—Apparatus for regulating the supply of air furnaces.
2764. M. Stodart, 1, Golden-sq. — Construction of sound boards of pianofortes.

Dated 31st October, 1857.

2766. H. J. Viault and J. Viault, Paris—Mechanism for making signals on railways.
2768. T. Lowe, Birmingham—Feeding screws, blanks, shanks, pins, and other such like articles, to turning, nicking, and worming lathes or machines.
2770. L. de Landfort, Higher Broughton, near Manchester—Apparatus for protecting the contents of pockets of wearing apparel.
2774. P. Gabbitas, Worksop, Nottingham—Washing machines.
2776. J. Fry, Watling-st.—Cementing fabrics when india rubber is employed.
2778. J. L. Norton, Bow, Middlesex, and E. Wilkinson, Leeds — Extracting oil and grease from wood previous to its being manufactured into yarn or fabrics.

Dated 2nd November, 1857.

2780. N. Matthews, Dodworth, near Barnsley, York—Pumps.
2782. M. F. Isoord, Paris—Producing heat and light.

Dated 3rd November, 1857.

2787. S. Hoga, Charlotte-st., Fitzroy-sq. — Electric telegraphs.
2788. J. Mallison, jun., Bolton-le-Moors—'Gassing' yarn and textile fabrics.
2790. W. J. Curtis, 1, Crown-ct., Old Broad-st.—Machinery for slotting, boring, and surfacing.
2792. H. K. Sweet, Northumberland-st., Strand—Photographic portraits and pictures.
2796. J. Seithen, Earl-st.—Machinery for cutting cork.

Dated 4th November, 1857.

2797. R. Laming, Hayward's-heath—Purifying gas, and apparatus for that purpose.
2798. W. F. Batho and E. M. Bauer, Salford, near Manchester—Machinery for drilling and boring metals, and also for cutting key-ways and cotter holes.
2799. F. Higginson, Woodlands-cottage, Woodlands, Hants—Submerging, extending, and laying down submarine telegraph cables.
2800. J. Murphy, Newport, Monmouthshire — Permanent way of railways.
2801. R. I. C. Dubus, Brussels—A method of treating certain plants or vegetable substances, in order to extract from the same—1st, a kind of fecula or farina proper both for alimentary and finishing or starching purposes; 2nd, an alcoholic liquor; aud 3rd, a natural ferment or yeast.
2802. C. E. Amos, the Grove, Southwark—Steam machinery for driving rotary pumps.
2803. C. Clay, Walton, near Wakefield — Machinery for grubbing or cutting up weeds.
2804. J. Houghton, Kilburn—Braces.
2805. J. Miller, Alpha-rd., Regent's-pk. — Marine steam engines.

Dated 5th November, 1857.

2807. J. Bunnett, Deptford — Machinery for banding and shaping metals.

2808. H. Bessemer, Queen-st.-pl., New Cannon-st.—Treating iron ores.
2809. G. Robinson, High-st., Deptford—Apparatus for hulling coffee.
2810. H. Beinhauer, Deutz, near Cologne—Machinery for drawing or extracting water from mines, wells, or pits
2811. J. J. Cousins, Park-la., Leeds—Steam ploughs.
2812. H. Hochstaetter, Darmstadt—Machine for the manufacture of matches.
2813. W. Sharman, Sheffield—Metallic compound, resembling German silver.
2814. H. R. Palmer, Lambeth—Stamping and endorsing machine.

Dated 6th November, 1857.

2815. F. Lipscombe, Strand—Mode of conveying water.
2816. R. K. Aitchison, New North-st.—Break, applicable to wheeled carriages.
2817. G. Canouil, Paris—Matches.
2818. W. Anderton, Ince-within-Mackerfield, Lancashire—New railway chairs.
2819. H. Bessemer, Queen-st.-pl., New Cannon-st.—Manufacture of malleable iron and steel, and railway and other bars.
2820. W. Macnab, Greenock—Vessels propelled by screw.

Dated 7th November, 1857.

2821. H. Baines, Manchester—Machinery for the prevention of accidents.
2822. J. Fordred, Stoke Newington—Treating and purifying water.
2823. J. H. Pepper, Royal Polytechnic Institution, Regent-st.—Displaying various devices when revolving discs are used.
2824. J. Adams, Queen's-rd., Dalston—Revolver fire-arms.
2825. W. Wilson, 1, Canterbury-pl., Newington, and J. J. J. Field, 11, Sussex-st., Wandsworth-rd.—Casting or moulding liquified and other substances.

Dated 9th November, 1857.

2826. P. Brotherhood, Chippenham—Boilers and furnaces.
2827. W. Hardie, 6, Pitt-st., Edinburgh—Stereoscope.
2828. D. Stothard, Lambeth, J. Jones, Southwark, D. Jonas, and B. W. Jonas, Spitalfields—Ship's block.
2829. P. A. Balestrini, Brescia, Italy—Machinery for paying out submarine telegraph cables.
2830. J. Pinker, Pease-st., Hull — Governors for marine steam engines.
2831. A. R. le Mire de Normandy, Judd-st., Brunswick-sq.—Soap.
2832. A. Parkes, Bath-row, Holloway-head, Birmingham—Manufacture of nails.
2833. G. Weedon, Gloucester-pl., Portman-sq., and T. T. Weedon, Plumstead—Knife cleaning machine.
2834. W. J. Elwin, Dartford, Kent—Night lights.
2835. J. Reeve, 46, Rutland-gate—Propelling vessels.

Dated 10th November, 1857.

2837. T. Rowcliffe, 26, Upper Park-pl., Dorset-sq. — Machinery for making and pressing bricks, drain pipes, and tiles.
2838. C. E. Lecointe, Paris—New mode for advertising.
2839. J. Townsend, Glasgow — Manufacture of sulphurous acid.
2840. A. Parkes, Bath-row, Holloway-head, Birmingham—Manufacture of tubes and cylinders of copper and alloys of copper.
2841. J. T. Way, Welbeck-st., Cavendish-sq. — Obtaining light by electricity.
2842. J. Harrington, 9, Glo'ster-pl., Brixton-rd.—Apparatus for pointing pencils.
2843. H. C. Bartlett, Ampthill-sq., Hampstead-rd.—Manufacture of paper.

Dated 11th November, 1857.

2844. H. and S. Thompson, Regent-st.—Pianofortes.
2845. P. Madden, 1, Russell-pl., Dublin—Kilns for drying corn, &c.
2846. J. R. Cochrane, Glasgow—Ornamental fabrics.
2847. O. W. Wahl, 27, Leadenhall-st.—Manufacturing farinaceous products from potatoes.
2848. I. Taylor, Stanford Rivers—Apparatus used in printing calico and other fabrics when cylinders are employed.
2850. A. J. Davies, 29, George-st., Hanover-sq.—Sandal for bathers.
2851. J. Williams, Neath, Glamorganshire—Coupling and connecting carriages on railways.

Dated 12th November, 1857.

2852. E. Coleman, Dudley, Worcester—Lathes for turning bolts and screws.
2853. J. Stevenson, jun., Glasgow—Lighting apartments and passages.
2854. F. H. F. B. de Sivray, Paris—Bedsteads.
2855. S. Webster, Bolton-le-Moors—Apparatus for tanning.
2856. W. Picking, Lambeth—Feeding steam boilers.
2857. G. T. Bousfield—Loughborough-pk., Brixton—Castors.

Dated 13th November, 1857.

2836. W. Devon, 4, Maryland-ter., Stratford — Self-acting apparatus for flushing water-closets.
2858. W. J. Gifford, 23, New Millman-st.—Making, reefing, and working of sails, and in the construction and arrangement of masts, spars, and rigging.
2859. G. Sheppard, Fordingbridge, Hants—Machinery for cultivating land.
2860. W. J. M. Rankine, University of Glasgow—Fan blowers.
2861. A. H. A. Durant, Conservative Club, St. James's—Apparatus for husking and winnowing castor seeds for the purpose of obtaining the larger quantity and a purer kind of oil therefrom when pressed than heretofore with the outer skin or cuticle on.
2862. H. Bessemer, Queen-st.-pl., New Cannon-st.—Treating and smelting of iron ores.

Dated 14th November, 1857.

2863. G. Haseltine, Washington, U.S.—Machinery for the manufacture of small metallic chains.
2864. G. P. Wheeler, Abbingall, near Mitcheldean, Gloucestershire—Preparation of materials for the manufacture of paper pulp.
2865. J. H. Bennett, 8, Vambrugh-pl., Leith—Compound safety valves.
2866. J. Macintosh, North-bank, Regent's-pk. — Preparing telegraphic wire, which is coated with gutta percha, in order to render it more capable of resisting heat, and in laying down telegraphic wires in the sea.
2867. A. V. Newton, 66, Chancery-la. — Apparatus for retarding and stopping the progress of railway trains.
2868. M. Henry, 77, Fleet-st.—Electric and galvanic conductors, and machinery for manufacturing the same.
2869. J. Fereday, Wolverhampton—Steam engine.

Dated 16th November, 1857.

2871. J. B. Donas, 36, Rue de l'Echiquier—New optical instrument ("physioscop").
2872. C. Debax-Talabas, Castres, France — Lithographic printing presses.
2873. J. E. Hodges, Leicester—Manufacture of looped fabrics.
2874. J. F. Spencer, Brighton—Steam engines and apparatus.
2875. J. Taylor, Birkenhead—Dredging machines.
2876. T. Richardson, Newcastle-on-Tyne — Treating manganese ores.

Dated 17th November, 1857.

2877. T. Field, Spring-pl., Kentish-town—Submerging submarine telegraph cables.
2878. W. Gossage, Widnes, Lancashire—Soap.
2880. D. Foxwell, Manchester—Materials for the backs of cards.
2881. W. Pidding, Southwark-bridge-rd.—Manufacture of piled fabrics, or of mosaic or tesselated textile and other fabrics, and improvements in some of the machinery or apparatus necessary to produce them, also the application of certain existing or known machinery or apparatus for their production.
2882. G. T. Bousfield, Loughborough-park, Brixton—Fire-arms and detonating compounds.
2883. S. P. Smith, Crescent, New York, U.S.—Iron wheels for railway carriages.
2884. R. A. Brooman, 166, Fleet-st.—Manufacture upon circular frames of a fabric suitable for petticoats, &c.
2885. R. A. Brooman, 166, Fleet-st.—Gas burners.
2886. W. E. Richardes, Bryn-Eithin, Aberystwith, South Wales—War-weapon.
2887. E. D. Johnson, Wilmington-sq.—Fuzee watches.

Dated 18th November, 1857.

2888. W. H. Bell, Pelton, Durham—Permanent way of railways.
2889. J. Tinker, Stalybridge, Cheshire—Sizing matter.
2890. E. Alcan, Fore-st.—Apparatus to be applied to looms.
2891. F. Ayckbourn, 4, Lyon's-inn, Strand—Bird cages.
2892. A. F., F. G., and J. Germann—Propeller.
2893. A. A. Salomon-Cohen, Paris—Machinery for manufacture of drain pipes, &c.
2894. R. Clegg, Islington—Registerimg the revolutions of machines or parts of machines.
2895. M. Booth, Manchester, and J. Farmer, Salford—Machinery for stiffening, drying, and finishing woven fabrics.
2896. P. Bettle, Messrs. Carley and Co., Ely-pl.—Watches.

Dated 19th November, 1857.

2897. W. Smith, St. Paul's Corner, Norton, near Malton, Yorkshire — Apparatus for protecting the turnip crop.
2898. C. W. Williams, Liverpool—Steam engine boilers.
2899. M. A. F. Mennons, 4, South-st., Finsbury—Washing and drying apparatus.
2900. J. B. Mirio, Paris—Permanent way of railways.
2902. T. H. H. Kelk, Tonge, near Ashby-de-la-Zouch—Metallic alloys.
2903. S. Gill and H. Newton, Liverpool—Obtaining stereoscopic pictures.
2904. W. Clay, Liverpool—Metal knees employed in the construction of ships, buildings, &c.
2905. W. Clay, Liverpool—Points, switches, and crossings of railways.
2907. R. Goedicke, 29, John-st., Bedford-row — The suspending of the lines of electric telegraphs in the air by means of gas balloons across water and land, or the atmospheric telegraph.
2908. D. Melvin, Glasgow — Machinery for manufacturing heddles or healds for weaving.
2909. J. Clarke, Shiffnal—Construction of shafts and poles for cabs and other vehicles.
2910. J. E. B. Curtis, St. James's-rd., Croydon—Apparatus for filing papers and documents.
2911. J. Cope, Birmingham—Buttons
2912. T. F. Bradson, Birmingham, and G. Hughes, Yardley, Worcester—Door springs.
2913. W. J. Cantelo, Camberwell—Preparations of graves or cracklings for the purposes of animal food and manure.
2914. B. Keightley, Lofthouse, Wakefield — Apparatus for indicating and registering the flow or supply of air to mines, &c.
2915. C. L. West, 25, Rupert-st., Haymarket — Window sashes.

Dated 20th November, 1857.

2916. J. Hinks and G. Wells, Birmingham, and J. L. Petit, Aston, near Birmingham—Metallic pens.
2917. J. Denton, Pendleton, near Manchester—Looms.
2918. H. Walker and J. Beaumount, Sandfield-house, Mirfield, Yorkshire, and J. Gothard, Huddersfield—Steam engines.
2919. H. Page, Whitechapel-rd.—Sheet and crown glass.
2920. P. A. Brussaut, Mont de Marsan, France—Anti-friction apparatus for shafts, axles, and other revolving surfaces.
2921. H. Bessemer, Queen-st.-pl., New Cannon-st.—Manufacture of iron and steel.

Dated 21st November, 1857.

2922. W. A. Cooper, Dungannon, Ireland—Navigation of steam vessels.
2923. T. Glover, Upper Chadwell-st., Myddelton-sq., and A. Bain, Fetter-la., Holborn—Electric telegraphs.
2924. N. F. B. de Chodzko, Paris—Furnaces for boilers.
2925. G. J. Benson, Christian-st., St. George's-in-the-East—Moulded sugar.
2926. S. Hall, 19, King's Arms-yd., Moorgate-st.—Apparatus for igniting matches.
2927. J. M. A. E. Fabart, Paris—Looms for weaving.
2928. J. Wright, 19, Alfred-pl., Newington-causeway — Treating madder for printing, dyeing, distilling, &c.

Dated 23rd November, 1857.

2929. S. Riley, 1A, Victoria-ter., Victoria-st., Manchester—Chocolate and cocoa.
2930. W. McFarlane, Glasgow—Moulding cast-iron pipes.
2932. C. Barlow, 89, Chancery-la.—Steam and air engines and furnaces.
2934. D. Hulett, 55 and 56, High Holborn — Cocks, taps, and valves.

Dated 24th November, 1857.

2936. T. C. Wilkinson, Ashford, Kent—Pump valves.
2937. J. Schloss, 75, Cannon-st. West—Diana lock.
2938. G. Lowry, Salford—Machinery for heckling fibrous materials.
2939. W. Searby, Newgate-st.—Elastic spring, applicable to bedsteads, sofas, chairs, &c.
2940. C. Sands, Felix-ter., Liverpool-rd.—Stereoscopes.
2941. A. F. Butler, Ceylon—Machinery for pulping coffee.

Dated 25th November, 1857.

2943. R. Willan, J. Abbott, and D. Mills, Blackburn, Lancashire—Looms.
2945. A. and J. Martin, Trieste—Preventing the deposits and incrustations in boilers.
2947. J. Hogg, London—Safe.

Dated 26th November, 1857.

2949. W. T. Manning, 20, Great George-st., Westminster—Treatment of sewerage.
2951. C. Farrow, Great Tower-st.—Fire-arms.
2953. H. Woodward, Birmingham—Knife cleaner.
2955. J. Higham and G. D. Bellamy, Plymouth—Manufacture of soap.

Dated 27th November, 1857.

2957. T. Wheeler, Albion Works, Oxford—Machinery for cutting turnips.
2959. W. Elcock and S. Bentley, Wednesbury—Elbows for joining wrought-iron and other pipes or tubes, and in tools for manufacturing the said elbows.

Dated 28th November, 1857.

2961. A. Vandeleur, Royal Arsenal, Woolwich—Fireplaces and passages for air of air furnaces.
2963. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—"Tell-tale" clock.
2965. W. Binns, Claremont-villa, Victoria grove, Brompton — Application of surcharged or superheated steam.
2967. W. Massey, Newport, Salop—Guides or conductors to be applied to machinery or apparatus employed for winding or coiling chains, ropes, lines, thread, wire, or other similar articles.

Dated 30th November, 1857.

2969. J. Gardner, R. Lee, and H. G. Pearce—Self-reefing sails.
2971. H. Deacon, Woodend Chemical Works, Widnes Dock, near Warrington—Apparatus employed in the manufacture of caustic soda.
2973. J. P. de la Fons, Carlton-hill, St. John's-wood—Apparatus for retarding omnibuses.
2975. R. A. Brooman, 166, Fleet-st.—Casks, &c.
2977. C. Goodyear, Leicester-sq.—Manufacture of buoyant fabrics.

DESIGNS FOR ARTICLES OF UTILITY.

4034. Nov. 26. J. Dixon and Sons, Sheffield, "A Lever and Cutter for Shot Pouch Top."
4035. Dec. 8. S. Jones, 75, High Holborn, "The Chain Pocket, to prevent picking and cutting."

INVENTION WITH COMPLETE SPECIFICATION FILED.

2849. E. Halliday, Ashcroft, Massachusetts, U.S.—Preventing the overheating and bursting of steam-boilers.—11thNovember, 1857.
2879. J. Gedge, Wellington-st. South, Strand—Stopping or retarding carriages used on ordinary roads.—17th November, 1857.
2901. H. D. Pochin and J. Woolley, Manchester—Gum or dextrine.—19th November, 1857.
3023. F. O. Ward, Cork-st., Burlington-gardens—Manufacturing manure and obtaining products.—5th Dec., 1857.

DETAILS OF THE GUN BORING MACHINE,

FOR THE GUN FOUNDRY AND BORING MILL,

WOOLWICH ARSENAL,

BY JOHN ANDERSON, ESQRE

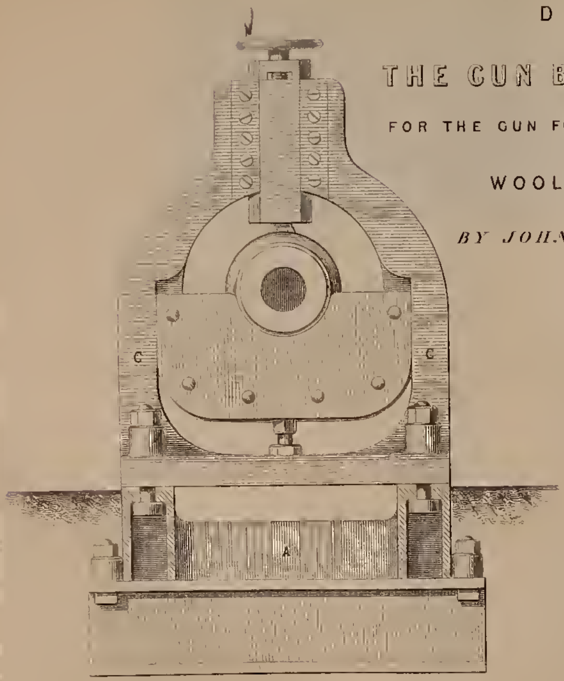


FIG. 3.

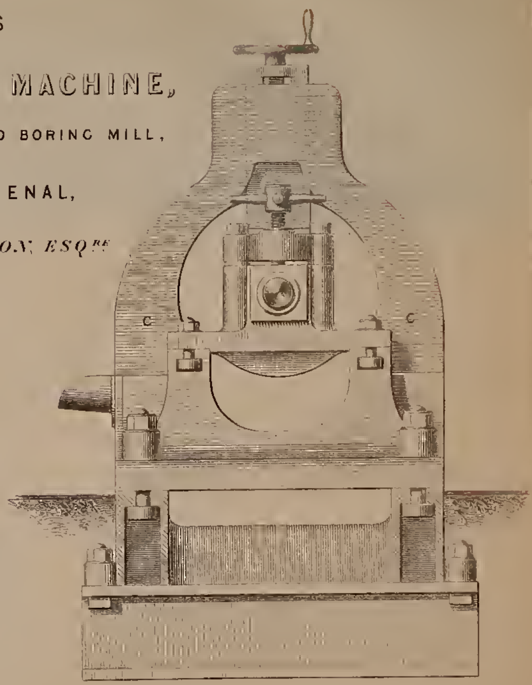


FIG. 4.

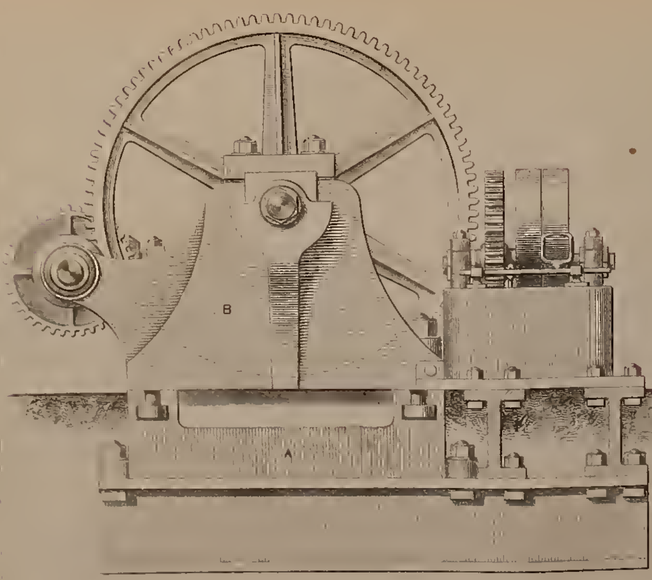


FIG. 5.

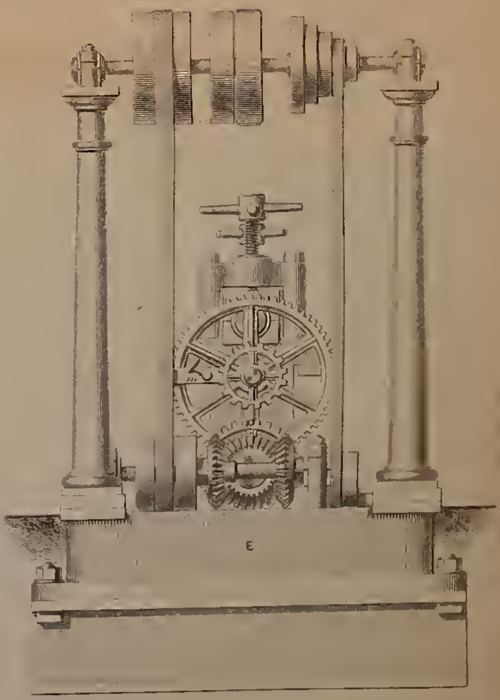
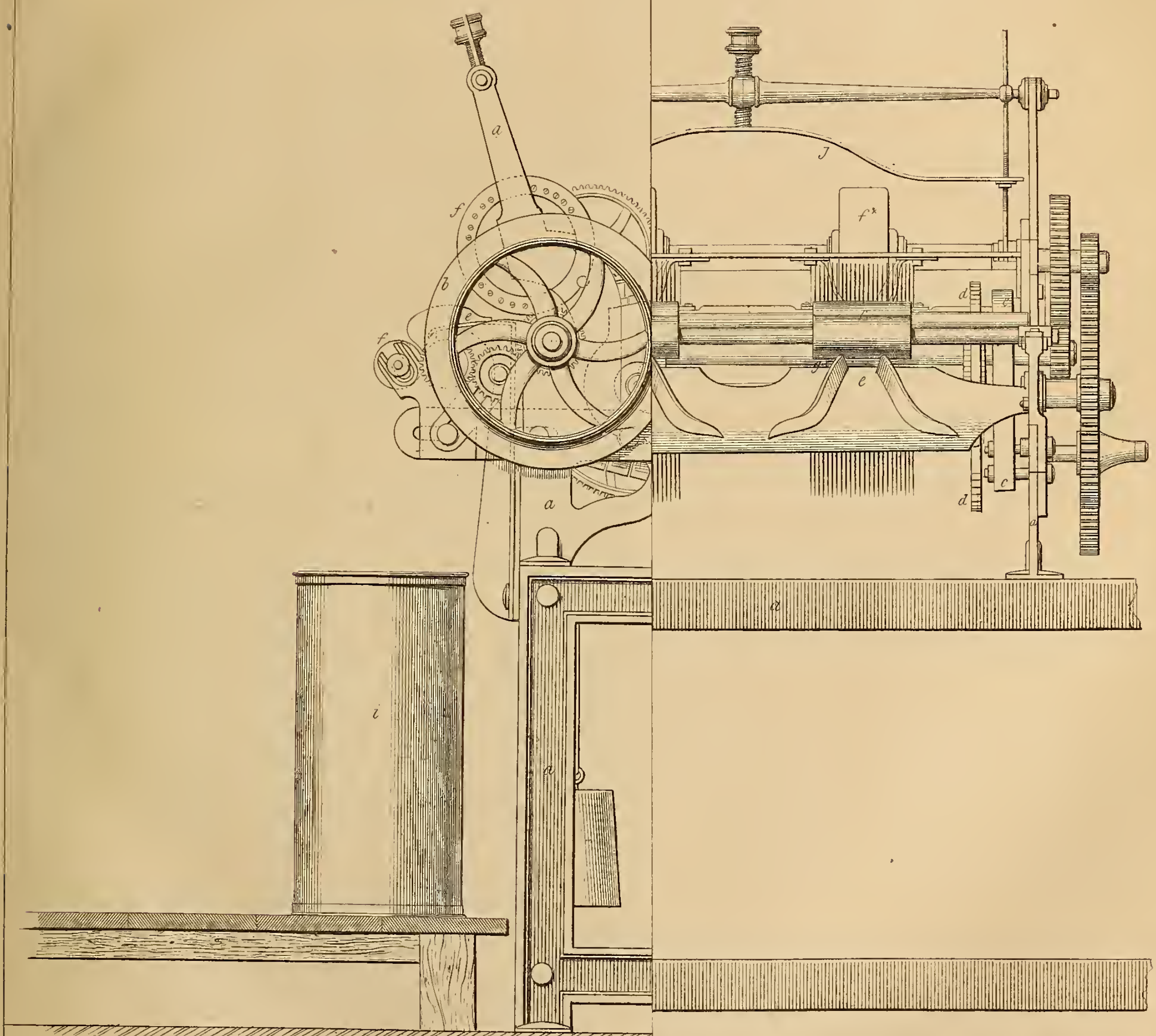


FIG 6.

280
280
281
281
281
281
281
281
281
28
28
28
28
28
28
28
28
2
2
2
2
2
2
2
2

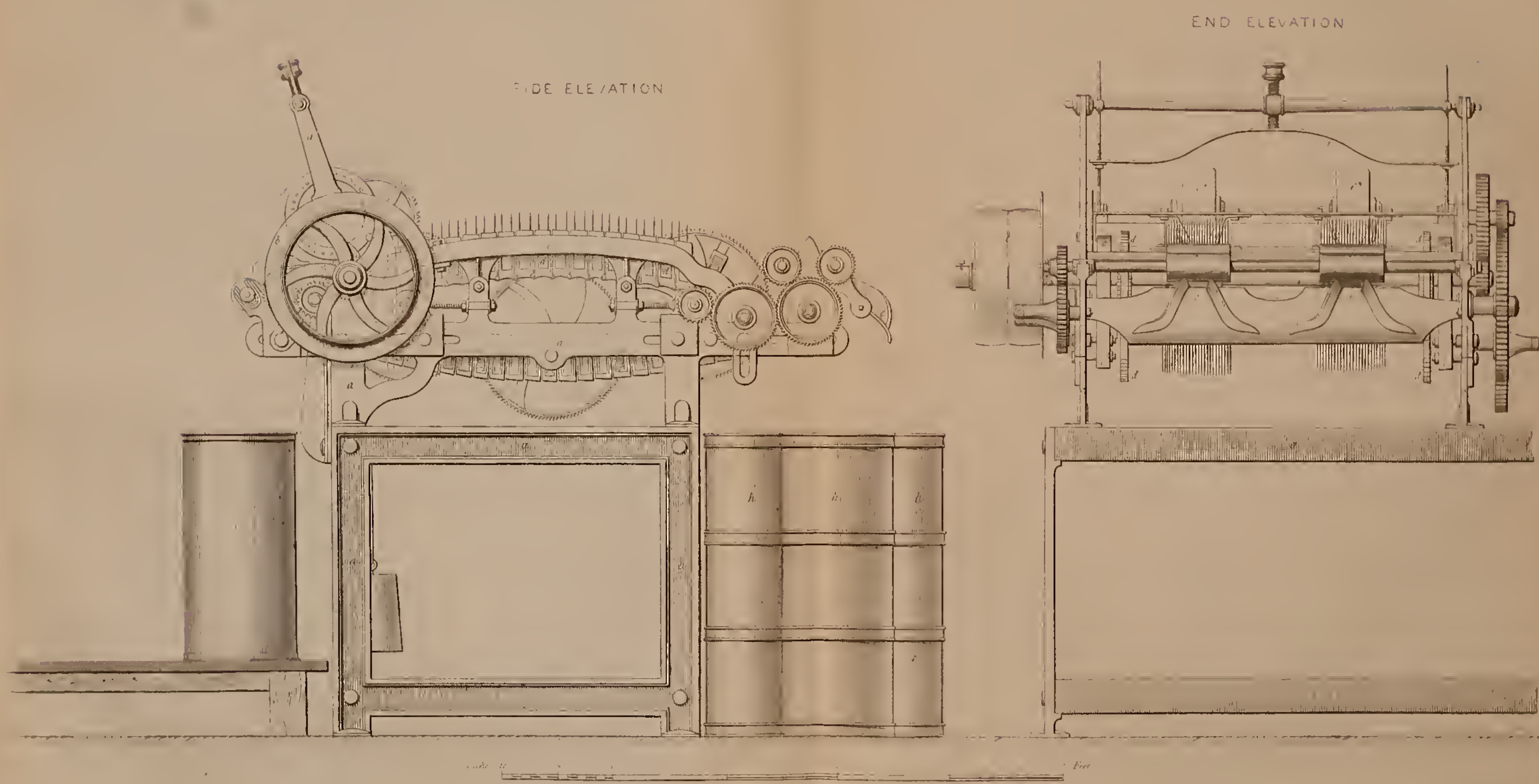
SID

ND ELEVATION



W. Smith, C.E. direx.t

SIDE AND END ELEVATION OF SECOND PREPARING MACHINE.



THE ARTIZAN.

No. CLXXXI.—Vol. XVI.—FEBRUARY 1st, 1858.

HEMP AND FLAX SPINNING MACHINERY.

(Illustrated by Plate No. cxvii.)

We have already presented our Subscribers with illustrations of machinery employed for preparing Hemp and Flax for the process of spinning into threads for the purpose of being manufactured into Ropes, Lines, and Cords of various kinds; and, in selecting the illustrations, we have confined our choice to those which have been thoroughly tested, and are known to work satisfactorily; and, although various patents have from time to time been obtained for improvements in this branch of manufacture, as in every other manufacturing operation to which the talent, ingenuity, and mechanical skill of our countrymen have been directed, we prefer rather to give as our first illustrations upon this subject the details of machines which have been used, are found to answer, and are still in use; and afterwards give illustrations of the progressive improvements which have been made—and this we propose to do on some future occasion; in the meantime we give, in the accompanying Plate,

A Side and End Elevation of the Second Preparing Machine, in which *a* is the frame; *b*, riggers; *c*, slides; *d*, links; *e*, guides; *f*, rollers; *g*, grooved ditto; *h*, delivery cans; *i*, filling can; *j*, spring for pressing rollers upon sliver.

As the mode of action of the heckle frame, as well as of the drawing rollers, is similar to that of the machine before described, it will not be necessary to repeat the description of the same, or of the gear work by which their motions are regulated; but it will be seen that the heckle pins differ from those of the former machine, by being in two distinct sets, and adapted for operating upon six of the slivers prepared in the first machine, which are placed before it in as many cans, *h*. The ends of the slivers are first introduced through the guides, *e e*, passing over the grooved roller, *g*, and pressed upon by the wooden rollers, *f f*, by which three slivers, combined into one, have their fibres again separated and combined into a more parallel direction by the heckle pins, at the same time that the whole is urged forward and drawn out by the action of the rollers, *f f*, between which the hempen riband passes after leaving the heckles, and which rollers, moving with a far greater velocity than the rollers, *g g*, cause the bundle of fibres to be regularly drawn out into a thinner and more regular stream, and by its subsequent compression between the rollers, to attain the degree of cohesion that enables it to undergo the next process. The machine, therefore, delivers through the guides, *e e*, two equal slivers at the same uniform velocity into can, *i*, an operation called doubling: *j* is a spring, whose power is regulated by a screw, by means of which the requisite degree of pressure may be given to the rollers, *f f*. It is to be observed that any greater number than three of the slivers prepared in the first machine, are passed through each set of heckle teeth on this occasion, accordingly as a thinner or thicker yarn may be required for different purposes. The double sliver thus made, is then removed to a third preparing machine, exactly similar to the one last described, where it is still further drawn out into a single and more uniform sliver, and received into a delivering can, in which state it is now passed to another machine called the compressor.

MACHINERY OF THE WAR DEPARTMENT.

THE NEW GUN-BORING LATHES ERECTED AT WOOLWICH FOR BORING LARGE IRON ORDNANCE.

(Illustrated by Plate No. cxvi.)

Having given in our January Number a somewhat elaborate plate and description of the gun-boring machine for the Gun Foundry and Boring Mill, Woolwich Arsenal, in which is exhibited a side elevation and plan of the machine, we have thought it desirable, and for the better elucidation of the subject, to give other views of the machine, which views will be found by reference to Plate cxvi., in the present Number, being respectively Figs. 3, 4, 5, and 6.

Fig. 3 exhibits a front view of the collar frame for carrying or supporting the muzzle of the gun; also showing the vertical adjustment.

A is the bed-plate, which is bolted to cast-iron girders, the upper surface of the bed being flush with the floor line. Upon the top of the bed-plate is bolted the collar-frame, C, in which the muzzle of the gun to be bored rests, and is made adjustable to suit different sizes of guns. In the centre of the collar frame, and above the muzzle of the gun, is the vertical adjustment, which is simply a sliding piece, adjustable by a small hand-wheel, as will be seen by reference to the Figure.

Fig. 4 is a back view of the collar frame, with the adjustable bearing for the boring-bar mounted thereupon, but which scarcely needs explanation, it being merely a square collar working in guides, through which the boring-bar passes, and is adjustable by a hand-screw. A semicircular trough, which is shown in the Figure as projecting from the side thereof, immediately under the muzzle of the gun, and extending across the whole width of the lathe, is for the purpose of catching the refuse of the gun during the boring operation.

Fig. 5 is an end elevation of the machine, exhibiting the driving head-stock and the necessary gearing, B being the head-stock for carrying the breech end of the gun.

Fig. 6 exhibits an end elevation of the boring apparatus and driving gear, and described in our January Number; A being the bed-plate; E, the gear-box, bolted to the end of the bed-plate, A; *m* is the lever worked by hand for actuating the saddle which carries the boring-bar during the operation of finishing the bottom of the bore.

ON THE ADAPTATION OF SUSPENSION BRIDGES TO SUSTAIN THE PASSAGE OF RAILWAY TRAINS.

Read before British Association, Section G.

By Charles Vignoles, Esq., C.E., F.R.S.

The following observations are submitted to the Mechanical Section of the British Association, as appearing to possess sufficient interest for discussion, from the circumstance of differences of opinion amongst civil engineers having thrown doubt upon the feasibility of applying the principle of suspension to the purpose of railway transit.

But the practical success in America of this principle, on a large scale, may be quoted as an example in its favour, and is a striking set-off against the failure in this country, which occurred upwards of five and twenty years ago, under circumstances which have militated against any attempt to repeat the experiment.

Some debate on this question took place in the Institution of Civil Engineers of London last spring, at a meeting from which many engineers were absent; and as the subject was on the intended application of a suspension-bridge to carry a railway across a navigable river in the North of Ireland, further inquiry may not be wholly uninteresting at a meeting held in the Irish capital, where many engineers and other practical and scientific men may be present, who, not having had a previous opportunity of joining in the inquiry, may be disposed to propound their opinions.

A further reason for bringing this subject forward, and one which will naturally create a more extended interest in the discussion, is, that the recent events in India cannot fail to produce among the remedial measures to be applied, a general and a more rapid extension of railways, even to the most remote parts of our Asiatic dominions; and in the course of this extension many rivers of great breadth must be bridged.

It is desirable to condense the matter into a few salient and important points; and it may be generally assumed that the whole inquiry is comprised under the following heads, viz.:—

1st. The maximum load to pass the bridge,
2nd. The velocity of the train,
and these being given there are these to be determined:—
3rd. The strength of the chains,
4th. The rigidity of the platform,
which having been duly provided for, the additional considerations will be as to
5th. Prevention of undulation, vibration, and oscillation.

1st. *Maximum Load to pass the Bridge.*—This load may be taken as equal to the weight of the locomotive engine and tender, and of as many carriages as will extend on a single line of railway along the platform of one whole opening between the suspension piers. To the consideration of such a single line the inquiry may be confined.

The length of the train, and consequently the weight on the platform of the bridge, will therefore be in proportion to the span or opening. The weight of an engine and tender may be taken, speaking roundly, at one ton per foot lineal of the railway over which they pass, and the weight of loaded carriages at half a ton per lineal foot. For a bridge with a clear opening of 400 ft., the weight of a train extending the whole length of the platform would average little more than half a ton per lineal foot; but as it has been generally customary to compute the insistant load on railway bridges at one ton per lineal foot on single line, this weight will be the one assumed.

2nd. *Velocity of the Train.*—It would be opening too wide a field upon the present occasion to inquire into or to attempt to solve the complex problem of what additional gravitating effect is produced upon railway structures by the percussive action of trains moving at different velocities. It must be admitted, *in limine*, that we have not at present sufficient justification to recommend that railway trains should be allowed to pass over the platforms of suspension bridges except at moderate speed, nor as a matter of every day practice should the locomotive engine be allowed to act except slowly while passing over such a bridge.

With these limitations of speed, and of action of the driving-wheels of the locomotive, the resistance to weight, which must be provided for in a railway suspension bridge, need not be more than to meet the maximum load above assumed; namely, one ton per lineal foot of the platform, in addition to the weight of the platform itself, of the chains and their accessories, and of the suspension-rods, all of which are matters of strict calculation dependant upon the span.

3rd. *Strength of the Chains.*—The mathematical theory of suspension bridges has been so fully entered into by the best foreign and English authors, more particularly by the French, amongst whom M. Navier is the most distinguished, that little need be said now, except to give the best admitted formula for calculation. There is so little practical difference in the form of the curve which the chain of a suspension bridge assumes when freely suspended without a load, and when fully loaded, that is, the difference in form between a catenary and a parabola, that the most esteemed writers on this subject have by common consent agreed to consider the curve of the chain of such a bridge to be a parabola rather than a catenary, on account of the very much greater simplicity of the mathematical calculations.

Perhaps it may not be irrelevant to enter very briefly into this.

When a heavy chain, freely suspended from two fixed points, is acted on by the force of gravity only, the form of curve which it assumes is called the *catenary*. If, however, the chain be loaded with weights distributed in such a manner that for each unit of length (*ex. gr.* for each foot), measured along the horizontal tangent at the lowest point of the curve, the weights should be equal to each other, the effect of such a distribution is to cause the curve of the chain to approach in form to another curve called the *parabola*. If the distributed weights become so great that the weight of the chain may be neglected in comparison with them, the form which the curve assumes in this case is accurately that of the parabola.

In most, if not all ordinary cases, the weight of the chain is, however, never inconsiderable in relation to that of the platform and of the testing load together; consequently, the form of the chain is never exactly that of the parabola, though it approaches more nearly to this curve than to the catenary—so near, that for all practical purposes it may be considered to have attained that form, viz., of the parabola.

In the case where the curve of the principal openings has a chord, say, for instance, of 424 ft., and a versed sine of 29¼ ft., proportion between the chord and versed sine of between 14 and 15 to 1, the two curves (catenary and parabola) passing through the points determined by these conditions, approach so near to each other in form that their greatest distance measured in a vertical line, intersecting both of them, is only 0·6 (3-5ths) of an inch.

The formula by which the sectional area or strength of the chain for a suspension bridge may be accurately calculated, is as follows:—Considering the curve of the chain as a parabola, and referring to the exhibited sheet of explanatory data:—

FORMULA,

For Calculations relating to Suspension Bridges reduced to the Simplest Terms, and Considering the Curve of the Chain as a Parabola.

Unit of length	....	1 ft.
,, superficies	....	1 sq. ft.
,, volume	....	1 cubic ft.
,, weight	....	1 ton.

x = Half chord of parabolic curve of chain
y = Versed sine of do.
h = Semi-parameter of the parabola
} Clear of supports.

$$\text{N.B. } h = \frac{x^2}{2\,y} \text{ by the properties of the parabola.}$$

ω = Minimum sectional area of the chain, exclusive of appendages.
n = Appendages of the chain (see Explanations).
($\omega + n$ = Sectional area of chain, for calculating its *weight* and *tension*.
u = Weight of a *cubic foot* of *iron*.
ϵ = Maximum weight admitted on chain (see Explanations).
Sec. ϕ = Length of chain at top or highest part
Sec. ϕ = Do. at bottom or lowest part
k = Load on the chain (see Explanations).
l = Weight of the chain and its appendages
$k \quad l = p$ = Total maximum load on chain for calculating tension
} Corresponding to 1 ft. in length, measured horizontally along the chord of the parabolic curve of the chain.
T = Tension at any part of the chain.
r = Height or depth of abutment
P = Half length of abutment
} See Explanations.
W = Theoretical weight of abutment to resist tension.

FORMULA.

$$\omega = \frac{k \times \sqrt{h^2 + x^2}}{\epsilon - u.\,n.\,\phi\text{sec.}\ \sqrt{h^2 + x^2}} \text{ For sectional area of chain.}$$

$$\mathrm{T} = \mathrm{P}\sqrt{h^2 + x^2} \ \ldots\ldots\ldots\ldots \text{ For tension of chain.}$$

$$\mathrm{W} = \frac{\mathrm{T}\,r}{\mathrm{P}} \ \ldots\ldots\ldots\ldots\ldots\ldots \text{ For resistance to tension.}$$

4th. *The Rigidity of the Platform.*—This is perhaps the most important point of the subject, and has probably hitherto been least considered, and, strictly speaking, the novelty of the inquiry is confined to this alone.

In all the earlier examples of suspension bridges, the object of the engineer appears to have been to construct the platform as light as possible. In many instances this was carried to a most dangerous extent; even in the case of the great suspension bridge over the Menai Straits, the platform has been repeatedly damaged by storms of wind, which twisted it as if made of pasteboard. The late Mr. Rendel was the first engineer who perceived the mistake which had been hitherto committed in this respect. When the suspension bridge at Montrose had been destroyed, about 12 or 14 years ago, he reconstructed the platform, and stiffened it by bracings so effectually that it has since remained uninjured. This principle of strengthening the suspended platform was carried out to a greater extent by the writer of these observations at the bridge over the Dnieper, at Kieff, in Russia, and the successful resistance of this well-braced platform, to the effect of hurricane winds, and to vibration, oscillation, and undulation, has been very remarkable.

The desideratum is, that the platform of a suspension bridge intended to sustain a railway train should be made as stiff as possible; and the first natural consideration is, how is this stiffness or rigidity to be best obtained?

The mode in which this has been effected in the Great Niagara Suspension Bridge, is on the system of a deep trellis frame, in fact a timber tube, the sides of which are of lattice work, the railway passing on the top.

It is generally understood, and a print published at the time seems to confirm this, that the original intention of Mr. Stephenson was to have added suspension chains for supporting the tubular platform of the Britannia Bridge, although that intention was subsequently abandoned, and the tubes made sufficiently stiff not to require their assistance.

Another great point in this discussion seems to relate to the adapting of suspension bridges for passing railway trains in localities and under circumstances where fixed bridges could not be erected except at an unjustifiable expense, or not at all, from the onerous conditions naturally or judicially imposed.

According to the locality, timber or iron may be best suited for constructing the platform, the platform being made as deep and as stiff as possible, and thus becoming a girder held up by suspension chains; and the stiffness being augmented by the increased depth of framing, it will be advisable that the rails should be attached thereto as high up as practicable.

But the weight of the platform must be kept within reasonable limits, to avoid too great an increase in the sectional area and weight of the chains, which would otherwise become necessary; and further precautions have to be taken as regards the distribution of the load on the platform, and to guard against oscillation and undulation, for all which due consideration must be given as to the proper breadth of the platform.

The weight of the platform of an ordinary suspension bridge was formerly scarcely more than 36 lbs. to the square foot of the area of the whole platform—the present weight of the Menai Bridge platform, after having been strengthened, is about 38½ lbs. to the square foot; the weight of the platform of the Montrose Bridge, as reconstructed by Mr. Rendel, is 41½ lbs. to the square foot; and the weight of the platform of the Kieff Bridge is 49½ lbs. to the square foot, including the two footpaths, which are corballed out from the main part of the framing; but the weight of that part of the platform between the chains, and which sustains the roadway, is about 60 lbs. to the square foot. The ordinary test load for a suspension bridge was about 62 lbs. to the square foot; the proof load put upon the Kieff Bridge was really about 84 lbs. to the square foot.

Now a railway load passing over a suspensiou bridge being taken at 1 ton per foot forward, the weight per square foot upon the platform will vary as the breadth of the bridge. If the breadth be 20 ft., the passing load will be 1 cwt., or 112 lbs. to the square foot. If 27 ft. wide, it will be 83 lbs., and if 30 ft. wide, 75 lbs. to the square foot. The Kieff Bridge is 52½ ft. wide, and therefore a passing load of 1 ton per lineal foot spread over this area is only 43 lbs. per square foot; whereas the test load was 84 lbs. to the square foot, which is about double what would have been the weight of the heaviest railway train; or taking 42 ft., exclusive of footpaths, the railway load would have been 52 lbs. per square foot, or less than two-thirds of the test load, which (it may be remarked here) remained on 48 hours without the platform showing any deflection visible to the eye, although some deflectiou really took place.

It appears, therefore, most undoubted, that suspension bridges of modern construction may be perfectly adapted to sustain the passage of railway trains, and that the chief consideration has to be given to the character and dimensions of the platform; and, as a general rule, I would suggest, that notwithstanding the advantage to be gained by depth, this should not be carried too far—more especially if the lattice-girder system be adopted, and presents too mnch surface to the wind, and thus induce increased lateral oscillation. Also, that the breadth of the platform for a single line should not be less than 25 ft., in order to spread the load, and reduce the insistent weight per square foot of platform.

It might be interesting to establish a comparison of the expense of various descriptions of platform, but these would lead too much into detail, and the materials for this purpose have yet to be collected; still, as a contribution, and by way of illustration, the present opportunity may be taken to state the cost of the platform of the Kieff Bridge, already mentioned as so remarkably stiff and capable of sustaining the transit of a railway train.

In a length of 12 ft. of the whole breadth of 52½ ft. of the platform, the quantity of materials was as follows:—

Timber, 600 cubic ft.	£150
Iron, 30 cwt.	30
	£180

for a length of 12 ft., or £15 per lineal foot of the whole breadth of the platform, which is something less than six shillings per square foot of a platform, such as that at Kieff, and of which the drawings are here shown.

5th. *The prevention of Undulation, &c.*—The effects upon a suspension bridge of passing loads and of strong winds, cause vibratiou, oscillation, and undulation. Of these, the undulation is considered to be the most serious.

The vibration may be assumed as produced by what may be called the percussive action of the passing load; and when the platform is not sufficiently stiff, and the passing action is irregular over the surface, as for instance by the impetuous rush of a drove of cattle, or of a multitude of people, oscillation and undulation ensue. The first producing a lateral swing of the platform—the latter arising from the bending of the platform in its longitudinal direction.

The remedy for vibration and oscillation is provided by a sufficiency of stiffness, not to say absolute rigidity, in the platform, which will also, to a certain extent, counteract the propagation of the undulation, but not entirely.

The experience, however, of four years on the Kieff Bridge, has proved that the mode adopted in that construction of disposing the suspension rods *alternately* in the manner shown on the exhibited drawings, has completely counteracted the undulation; and many very heavily laden carriages together, artillery, cavalry, and large bodies of troops, have been continually passed over the platform of this bridge without the slightest undulatory or oscillating motion having been produced.

We are hence enabled to infer, without looking to improvements in detail which will naturally be introduced, that a platform so constructed and so suspended as the one at Kieff, is capable of sustaining the passage of railway trains at a moderate velocity, and within a reasonable cost of construction; and taking the example of the Wire Bridge in America, and of this wrought-iron chain bridge in Russia, it may be legitimately concluded that the adapting of suspension bridges to railway purposes is perfectly practicable.

The extent to which this application may be made can scarcely be defined *à priori*; but the writer ventures, from his own experienee, to state his opinion, that where the span of the required bridge must exceed 300 ft., the suspension principle should be adopted for the sake of economy.

It would be extending these observations far beyond the bounds assigned to such meetings as these to go further into the details; and therefore, however tempting the opportunity, we must abstain from entering upon the subject of the modern mode of obtaining foundations and forming river piers, which mode would greatly influence any selection between a fixed or a snspension bridge.

Neither must we even touch upon the choice between the wire-rope and the wrought-iron plate-chain, as the means of suspending the platform, though it is obvious that when the span becomes very large, the superior lightness of the wire is a great inducement to decide the preference for it over the wrought iron.

The proportion between the chord and the versed sine of the curve of the suspending chain is another point of the highest interest, as raising the questions of more or less oxidation, and of increase or decrease in the amount of tension, as this proportion varies.

It is sufficient to have brought the general subject of the practicability of adapting suspension bridges to sustain the passage of railway trains before the Mechanical Section of the British Association; and it is to be hoped that this opportunity will not pass away without engineers and other scientific and practical men now assembled bringing their judgment and experience to a ventilation of this very important question.

AN INQUIRY INTO THE STRENGTH OF BEAMS AND GIRDERS OF ALL DESCRIPTIONS, FROM THE MOST SIMPLE AND ELEMENTARY FORMS, UP TO THE COMPLEX ARRANGEMENTS WHICH OBTAIN IN GIRDER BRIDGES OF WROUGHT AND CAST IRON.

By Samuel Hughes, C.E., F.G.S., &c.

(Continued from page 6.)

The following experiments on the tensile strength of Cast Iron are described by Mr. Hodgkinson in the Seventh Report, Vol. vi., of the British Association for the Advancement of Science:—

Description of Iron	No. of experiment.	Mean strength, or tearing weight per square inch of section.
		lbs. tons. cwt.
Carron iron, No. 2, h. b	3	13,505 .. 6 0½
Do. No. 2, c. b	2	16,683 . 7 9
Do. No. 3, h. b	2	17,755 .. 7 18½
Do. No. 3, c. b	2	14,200 .. 6 7
Devon, Scotland, No. 3, h. b.	1	21,907 .. 9 15½
Buffery, No. 1, h. b	1	13,434 .. 6 0
Do. No. 1, c. b.	1	17,466 .. 7 16
Coed Talon, N.W., No. 2, h. b. / Do. do. do.	2	16,676 .. 7 9
Do. do. No. 2, c. b. / Do. do. do.	2	18,855 .. 8 8

These experiments were made on bars having a sectional area varying from 1½ in. to 4 in.

The mean tensile strength of cast iron derived from Hodgkinson's experiments for the Commission of 1849, was 15,711 lbs. per square inch, and the ultimate extension $\frac{1}{600}$ of its length. And this weight would compress a bar of the same section $\frac{1}{775}$ of its length.

The Commissioners observe that the usual law is very nearly true for wrought iron.

This law is to the effect that up to a tensile strain of 12 tons per square inch, beyond which wrought-iron bars are seldom weighted, the extension is in proportion to the weight; so that here the modulus of elasticity becomes very important, as will be seen hereafter for calculating the extensions according to any tensile strain which may be applied.

Hodgkinson's Experiments on the Tensile Strength of Wrought Iron.

These experiments were made on rods 50 ft. long; one set was made on a rod ·517 in. in diameter; mean area of section ·2099 in.

The other set was made on a rod ·7517 in. diameter; mean area of section = ·44379 in.

First Set of Experiments.

The weights were applied by increments of 5 cwt. up to 50 cwt., or rather more than 10 tons per square inch.

Up to this weight the mean ratio of weight per square inch to extension or value of $\frac{w'}{e'} = 232223$, where w' is the weight in lbs. per square inch, and e' the extension in inches for a rod 10 ft. long and 1 in. square.

Then as 10 ft. = 120 in. the modulus of elasticity for this iron is $232223 \times 120 = \underline{27,866,760}$.

(The modulus of elasticity is $\frac{w}{e}$ where w is the weight for 1 sq. in., and e the extension for 1 in. of length).

The bar broke in the first set of experiments with a weight of 5 tons = $\frac{5}{\cdot 2099} = 23{\cdot}817$ tons for 1 in. square.

The utmost stretching with 50 cwt. = 26,676 lbs. per square inch, was only ·606 in., and the permanent set. ·049 in.: with the heaviest weight applied it stretched 21 in. before breaking.

Second Table of Experiments.

Here again the bar was weighted up to 10 tons per square inch without injuring its elasticity; the mean ratio of $\frac{w'}{e'}$ being 230,760, so that the modulus of elasticity $= 230760 \times 120 = 27{,}691{,}200$.

Mr. Hodgkinson has the following columns in his table:—

1st. Weight applied to stretch the rod in lbs., increasing 5 cwt. at a time; weight in lbs. $= w$.

2nd. Extension of rod on opposite sides, the mean in inches being taken $= e$.

3rd. Set of rod on opposite sides at first scarcely perceptible, but with 10 tons per square inch amounting to $\frac{1}{20}$ of e.

4th. Weight laid on per square inch of section $= \frac{w}{a} = w'$.

5th. Extension of rod if 10 ft. long and 1 in. square $= \frac{10\, e}{l} = e'$.

6th. Set of rod if 10 ft. long and 1 in. square $= \frac{10\, s}{l} = e''$.

7th. Ratio of weight per square inch to extension $= \frac{w'}{e'}$.

We have seen, page 6, that $\frac{W l a}{M} = e$, and it has been found by experiment that up to 15 or 16 tons the extension of wrought iron is remarkably uniform; that is, it increases as nearly as possible in proportion to the weight, 2 tons giving double the extension of 1 ton, and so on. Hence the extension per ton of weight and per square inch of section will be in parts of the length $\frac{2240}{M}$, or from Hodgkinson's Table 1, already quoted, it will be in parts of the length $\frac{2240}{27{,}866760}$, and from Table 2 it will be $\frac{2240}{27{,}691{,}200}$.

Mr. Clark proposes to take 28,000,000 as the modulus of elasticity, so that $e = \frac{2240}{28{,}000{,}000} = \frac{8}{100{,}000}$, which gives a simple rule to this effect, that every ton produces an extension per square inch $= \frac{8}{100{,}000}$, or $\frac{1}{12{,}500}$ of the length. Hence the extension per ton and per square inch $= \cdot 00008\, l$

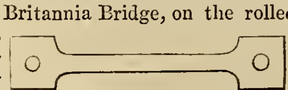
Mr. Clark gives a Table at p. 372 of his book, showing the observed and calculated extensions of a wrought-iron bar 10 ft. long and 1 in. square, from which weights were suspended increasing by 1 ton each time.

The column for calculated extension was derived from the formula $e = \cdot 00008\, l\, W$, and was found to be almost identical with the observed or actual extension up to 12 tons, beyond which the observed extension rapidly exceeds the uniform rate.

With the view of simplifying the calculation still further, Mr. Clark proposes to assume both the compression and extension of wrought iron to take place at the rate of $\frac{1}{10{,}000}$ of the length for every ton of direct strain. In this case, as 1 ton would extend the bar $\frac{1}{10{,}000}$, it follows that 10,000 tons, or 22,400,000 lbs. would extend it to the length of 1, or double its own length. Hence, according to this assumption, 22,400,000 would be the modulus of tensile elasticity.

Experiments on Boiler Plate, recorded by Mr. Edwin Clark.

These experiments were made at the Britannia Bridge, on the rolled plates and rivet iron employed in that structure. The specimens were prepared in the following form, the sectional area of the neck being always 1 sq. in. The weight was always applied in the direction of the length of the plate as rolled.



The specimen was suspended from a shackle, and broken by direct weight placed on a scale. The ultimate extension was measured on the fractured bar from punch marks previously made on the neck.

Experiments on the Ultimate Strength of Boiler Plate.

No.	Description of Plate.	Breaking weight per square inch.	Ultimate extension in parts of the length.
		Tons.	
1	Plate 11-16ths in. thick; neck $1\frac{1}{2}$ in. long. Selected as bad iron; fracture bright and crystalline, brittle; broke readily with blow from a hammer	22	—
2	From same plate	21	$\frac{1}{40}$
3	Plate, $\frac{1}{2}$ in.; neck, 6 in. Selected as bad iron, containing two laminæ of crystalline metal 1-3rd of the whole section	18	$\frac{1}{100}$
4	Plate, $\frac{1}{2}$ in; neck, 5 in. Selected as a good plate; about 1-10th of the section crystalline	19	$\frac{1}{48}$
5	Plate, $\frac{1}{2}$ in.; neck, 4 in. Iron perfectly uniform and fibrous; supported the weight 15 minutes	21	$\frac{1}{8}$
6	Plate, 11-16ths in. thick; neck, 5 in. Iron good; 1-40th of section crystalline	19	$\frac{1}{36}$
7	Plate, $\frac{1}{2}$ inch; neck, 5 in. Iron fibrous, except 1-50th of the section	18	$\frac{1}{23}$
8	Plate, $\frac{1}{2}$ in.; neck, 50 in.	19·6	$\frac{1}{37}$
9	Plate, 5-8ths in.; neck, 50 in.	19·3	$\frac{1}{33}$
10	Plate, $\frac{1}{2}$ in.; neck, 7 in.	19·6	$\frac{1}{19}$
11	Plate, $\frac{1}{2}$ in.; neck, 7 in.	20·2	$\frac{1}{24}$
12	Plate, $\frac{1}{2}$ in.; neck, 50 in.	18·7	$\frac{1}{39}$

Mr. Clark observes that from the mean of the above experiments the ultimate tensile strength of boiler plate appears to be 19·6 tons; and the ultimate strength is remarkably constant, although the iron comes from different makers—from Staffordshire, Derbyshire, and Shropshire. The ultimate extension, on the contrary, is extremely irregular. Mr Clark observes that, as regards boiler plates, the ultimate strength of 25 tons per inch, usually assumed for wrought iron, is evidently erroneous; and this strength was not obtained from any iron used in the Britannia Bridge. He then describes an experiment made on the works of Messrs. Mare, at Blackwall (now the Thames Iron Co.), on a quality denominated best scrap rivet iron, the fracture of which was perfectly fibrous, and the quality unusually good. This iron broke on an average with 24 tons per square inch, or 18·84 tons per circular inch. The length of the round rods experimented on was 60 in., the diameter 7-8ths of an inch, and the mean ultimate extension, which was uniform, 1-8th of the length.

Experiments to determine Ultimate Strength across the Fibre of the Iron. The following results were obtained:—

	Ultimate Strength. In direction of Fibre.		Across the Fibre.
Experiment 1	19·66	......	16·93
„ 2	20·20	......	16·70

The ultimate extension was also twice as great when the plate was broken in the direction of the fibre.

Mr. Clark concludes that the ultimate tensile strength of wrought-iron bars may be taken at 24 tons, and of wrought-iron plates at 20 tons per square inch, and the ultimate useful strength of the latter at 12 tons per square inch. Up to 12 tons per square inch the extension of boiler plate may be taken at $\frac{8}{100{,}000}$ of the length per ton per square inch of section.

Mr. Fairbairn has made some valuable experiments on wrought-iron plates, which were communicated to the Royal Society, in a Paper read 13th June, 1850. The extension produced by the weight was not ascertained in these experiments, but the following is a condensed statement of the results which were arrived at:—[See Table at the top of page 29.]

In these experiments it will be observed the strength is greater across the fibre in the ratio of 225 to 230; whereas, in Mr. Clark's experiments, the strength across the fibre was much less, being in the ratio of 199 to 168. M. Navier, who also experimented on this subject, made the strength of wrought-iron plates in the direction of the fibre 40·8, and across the fibre 36·4.

Thus, calling the strength unity in the direction of the fibre, Mr. Fairbairn makes the strength across the fibre .... 1·023
Mr. Edwin Clark .... ·845
M. Navier .... ·892
the two latter agreeing very nearly.

Description of Plate.	No. of Expmts.	Mean breaking weight in tons per sq. in.
Plates of Low Moor Yorkshire Iron, drawn in the direction of the fibre, area of section 2·00 × ·22 = ·44 sq. in.	4	25·77
Plates of same Iron, drawn in the direction of the fibre, area of section 2·00 × ·26 = ·52 sq. in.	1	22·76
Same Iron, drawn across the fibre, area of section 2·00 × ·22	1	27·49
Ditto, ditto, area 2·00 × ·26	1	26·037
Derbyshire Iron, drawn in the direction of the fibre, area of the section 2·00 × ·285 = ·57 in.	2	21·68
Ditto, ditto, drawn across the fibre, same area of section....	2	18·65
Shropshire Iron, drawn in the direction of the fibre, area of section 2·00 × ·265 = ·53 in.	2	22·826
Same Iron, drawn across the fibre, and same area of section.	2	22·0
Staffordshire Iron, drawn in the direction of the fibre, area of section 2·00 × ·26 = ·52 in.	2	19·563
Same Iron, drawn across the fibre, and same area of section.	2	21·01

SUMMARY.

	Mean breaking weight in the direction of the fibre in tons per sq. in.	Mean breaking weight across the fibre in tons per sq. in.
Yorkshire plates	25·770	27·490
Ditto	22·760	26·037
Derbyshire plates	21·680	18·650
Shropshire plates	22·826	22·000
Staffordshire plates	19·563	21·010
Mean	22·519	23·037

Mr. Fairbairn says, the mode of piling the rough bars before rolling may account for the difference between himself and M. Navier, who may have experimented on plates rolled from piles made up in a different manner. In this country the rough bars are piled in alternate layers at right angles to each other; and Mr. Fairbairn thus accounts for the great uniformity of the tensile strength in both directions. This explanation, however, does not account for the difference in Mr. Clark's experiments, where the strength across the fibre was only about 4-5ths of the strength in the other direction.

It is only justice to Mr. Fairbairn's experiments to say that they were made with a lever which is considered by some to afford more accurate results for tensile strength than the hydrostatic press. The lever can be weighted in the most gradual manner, and is free from the jerks and concussions that have been attributed to the hydrostatic press, and which are said to be peculiar to the mode in which the power is applied.

VARIOUS KINDS OF RIVETTED JOINTS.

The lap-joint is where one plate overlaps another. (Fig. 19).

The single rivetted lap-joint has only one row of rivets. (Fig. 20).

The double rivetted lap-joint has two rows, as in Fig. 21.

The jump-joint is where one plate butts against the other and does not overlap, the joint being covered by a separate plate. (Fig. 22).

The single rivetted jump-joint is shown by Fig. 23.

The double rivetted is shown by Fig. 24.

The single rivetted jump-joint, with two covering plates, in Fig. 25.

The double rivetted jump-joint, with two covering plates, in Fig. 26.

In his Paper of 1850, Mr. Fairbairn describes the result of experiments made on the tensile strength of plates rivetted in these various forms for the purpose of comparison with the solid plate. He found, as the mean of nine experiments, that plates rivetted in the form shown by Fig. 20, or having a single rivetted lap-joint, broke through the rivets with 18,590 lbs.; whereas the solid plate of the same sectional area required a force of 25,400 lbs. to tear it asunder.

Fig. 19.

Fig. 20.

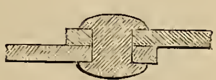


Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

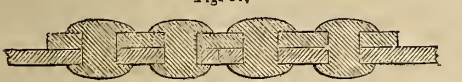


Fig. 25.

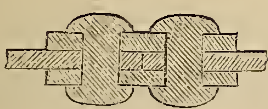


Fig. 26.

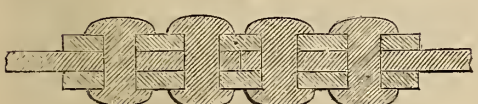


Fig. 27.

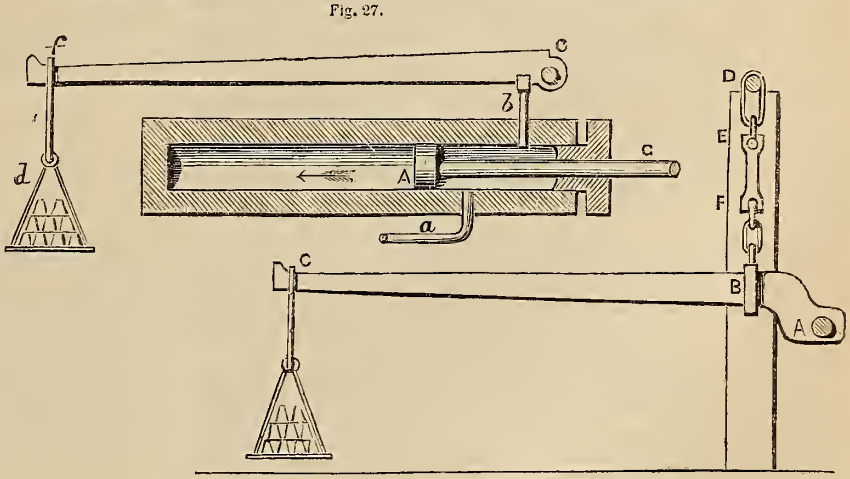


Fig. 28.

As the mean of three experiments he found the form in Fig. 21, or double rivetted lap, required 22,531 lbs.; and as the mean of five experiments, form shown in Fig. 24, or the double rivetted jump-joint with a covering plate on one side only, required 23,707 lbs.

From two extensive series of experiments, Mr. Fairbairn determines that the strength of the joints is to the strength of the plates of equal sections of metal as the numbers 1000 representing solid plate, 977 representing double rivetted jump-joints, Fig. 24, and 761 representing single rivetted lap-joints, Fig. 20.

"Exclusive of this difference, we must, however," says Mr. Fairbairn, "deduct 30 per cent. for the loss of metal actually punched out for the reception of the rivets, and the absolute strength of the plates will then be to that of the rivetted joints as the numbers 100, 68, and 46." In practice, however, considering that the rivets are somewhat wider apart than in his experiments, and that an increase of strength is gained by the adhesion of the two plates in contact, Mr. Fairbairn assumes the following as the relative value of the plates with their rivetted joints:—

Taking the strength of the plate at 100
The strength of the double rivetted jump-joint, Fig. 24, is.. 70
And the strength of the single rivetted lap-joint, Fig. 20, is 56

The following Table is given by Mr. Fairbairn as exhibiting the strongest form and best proportions of Rivetted Joints as deduced from the experiments, and from actual practice.

Thickness of Plates in inches.	Diameter of Rivets in inches.		Length of Rivets from the head in inches.		Distance of Rivets from centre to centre in inches.		Quantity of lap in Single Joints in inches.		Quantity of Lap in Double-rivetted Joints in inches.
		Ratio.		Ratio.		Ratio.		Ratio.	
$·19 = \frac{3}{16}$	·38	2	·88	4·5	1·25	6	1·25	6	For the double-rivetted joint add two-thirds of the depth of the single lap.
$·25 = \frac{4}{16}$	·50	2	1·13	4·5	1·50	6	1·50	6	
$·31 = \frac{5}{16}$	·63	2	1·38	4·5	1·63	5	1·88	6	
$·38 = \frac{6}{16}$	·75	2	1·63	4·5	1·75	5	2·00	5·5	
$·50 = \frac{8}{16}$	·81	1·5	2·25	4·5	2·00	4	2·25	4·5	
$·63 = \frac{10}{16}$	·94	1·5	2·75	4·5	2·50	4	2·75	4·5	
$·75 = \frac{12}{16}$	1·13	1·5	3·25	4·5	3·00	4	3·25	4·5	

The eolumns marked *ratio* in the preceding table, express the proportion between the thickness of the plate and the diameter, length, &c., of the rivets. For example: required the particulars of rivets for $\frac{1}{2}$ in. plates. Herc

	Inches.		Inches.
·5 × 1·5 =	·75	diameter of rivet	= $\frac{3}{4}$
·5 × 4·5 =	2·25	length of rivet	= $2\frac{1}{4}$
·5 × 4·0 =	2·00	distance between rivets	= 2
·5 × 4·5 =	2·25	quantity of lap	= $2\frac{1}{4}$

and

$$2{\cdot}25 \times \tfrac{5}{3} = 3{\cdot}75 \text{ quantity of lap for double joints} = 3\tfrac{3}{4} \text{ inches}$$

There is probably no branch of experimental inquiry in which more varying and discordant results have been attained than in that which seeks to determine the absolute strength of wrought iron subjected to a tensile strain, or to the action of a weight applied to tear it asunder.

It is obvious that the composition of the iron and the method of rolling, each exert an important influence on the strength. Thus, it is obvious, there must be an enormous difference in the quality of bar iron which is rolled direct from the puddling furnace without being cut and repiled and those superior kinds which are repeatedly cut up and re-rolled. Again, the descriptions of iron termed scrap, rivet, and faggot iron are, from the process of manufacture, very superior to iron rolled from refined metal only.

The best descriptions of scrap iron are made from a heterogeneous collection of all sorts of small wrought iron articles, such as broken wheel tyres, fragments of hoop iron, nails, horse-shoes, old screws, nuts and knobs, besides innumerable articles of domestic use which find their way into the stores of the old iron collector and marine store dealer. These scraps are made up into faggots or cubical masses of about a foot in every direction. The business of making up the faggots is usually performed by boys who work at the bundling bench in the following manner. The space for the faggot is defined by upright standards of iron placed about a foot apart. In the space between these uprights are placed two narrow strips of soft iron which are used to bind together the numerous pieces of which the faggot or pile is composed. At the bottom are laid the largest pieces of scrap, such as bits of coach tyre, hoop iron, and similar kinds of iron. The sides are also formed of flat pieces, eommonly old hoop iron, which is straightened for the purpose, and the interior is filled up with all sorts of small pieces. The top, like the bottom, is covered with the flat and large pieces, and when the pile is about a foot high, the strips of soft iron from the bottom are bent round the faggot and firmly twisted together. The faggot is then placed in the furnace, and, being heated to a welding heat, is withdrawn, and either formed into a bloom beneath a Nasmyth or tilt-hammer, or is passed between rollers with very large grooves, which reduce it somewhat to the form of a bar or a plate. It is then again heated and passed between other rollers, until the proper form is attained, whether this be that of bar iron, round or square, or whether it be flat plate, or some of the various forms of angle iron, or T iron now so extensively used in the arts.

The best Swedish bar iron is made from the finest descriptions of charcoal iron, and being also manufactured in a very superior manner, necessarily possesses great strength and tenacity. Iron wire, again, in consequence of the superior iron from which it is manufactured, and the minute sizes of which it is rolled, attains greater proportionate strength for a given area than bar or other iron of larger dimensions.

In addition to the differences which are due to these causes, it cannot be concealed that there is also a gradual and increasing difference in the quality of iron produced in successive years. The iron manufacture of this country has attained an enormous development, which, unfortunately, has not been accompanied by a corresponding increase of quality. On the contrary, all the earlier experimenters on iron found a greater strength than is now possessed even by the best qualities. It is foreign to the purpose of this article to trace the causes of this falling off and deterioration of a national manufacture, otherwise it would be very easy to show a case of serious national importance, which is perhaps more worthy of the attention of our legislators than those to which their labours are commonly applied. Whatever be the causes—whether the spirit of speculation, the race of competition between the great iron manufacturers to produce their iron at the cheapest rate, or the introduction of new and cunning chemical secrets to enable them to work up inferior iron—certain it is that our manufacture of wrought iron has been seriously deteriorating during the last half century, and unless some improvement shortly takes place, we shall, before long, acquire a reputation for manufacturing only inferior iron.

Another great injury to British manufactures, and to the fame of our iron works, is undoubtedly caused by the great multitude of indefinite and unintelligible brands and marks by which the trade chooses to designate iron of different kinds. These marks, as indications of quality, are not unfrequently absurd, contradictory, and ungrammatical. For instance, the expression *best scrap*, would, by ordinary persons, be interpreted to mean the *best* material which could be made out of scraps or pieces of old iron; but the manufacturer will tell you this is not its meaning, as there is another kind which he terms *best best scrap:* and not content with this repetition of superlatives, he has yet a further degree which is termed *best, best, best;* and an iron bar has been heard of with even four *bests* applied to it as descriptive of its quality. Can anything be more senseless and absurd than this? Mr. Edwin Clark relates, that in the course of his extensive dealings with iron-masters during the building of the Britannia and Conway Bridges, his eyes were gradually opened to the successive qualities denoted by this absurd repetition of prefixes. At first he thought, like other people, that *best scrap* really meant *best;* but he afterwards found, not only that there were many grades of quality far superior to *best*, but that *best* was in fact the commonest and most inferior kind of scrap iron that was made. Such is the interpretation put, in the trade, upon their own expression, *best scrap.* It is unnecessary for me to point out here the evils to commercial morality involved in such a misuse of words, nor the serious and ruinous consequences which have frequently followed, especially in contracts which have been made with foreigners and others, who could not be expected to know that *best* meant anything but that which it professes to mean—that *best*, in fact, was anything short of superlative.

Writers on the strength of materials in the last century seldom assigned to bar iron a less tensile strength than 30 tons per square inch as the weight which would tear asunder a bar of ordinary wrought iron 1 in. square.

Thus, Emerson gives the tensile strength of bar iron at 34 tons; Telford, 29·29; Drewry, 27 tons; while at the present day Templeton gives 25 tons; Beardmore, 26·8: Brown, 35 tons; and Eaton Hodgkinson, probably from more careful experiments than any other, 23·817.

The late Sir Mark Brunel made experiments thirty years ago on hammered iron of two qualities; one denominated *best*, the other *best best.* The former broke with a tensile strain of 30·6 tons per square inch, the latter with 32·3 tons. Mr. Drewry assumed, so lately as 1832, that 27 tons per square inch might be safely taken as the strength of the links of vertical bars in suspension bridges; and this, he says, is the mean given by Captain Brown's and Mr. Telford's experiments. It is believed that ordinary bar iron rarely, if ever, possesses this strength in the present day; and Mr. Hodgkinson's experiments show less than 24 tons. Mr. Edwin Clark's experiments on boiler plate ranged from 18 to 22 tons, as seen from table at page 28; and this is probably a fair representation of plate iron at the present day.

The tensile strength of Swedish bar iron is stated by Beardmore at 30 tons, and by Templeton at 32. The following is the strength of iron wire, as determined by various experimenters:—

	Tons.
Telford (mean of 6 experiments)	38·4
Dufour	38·4 to 40·75
Vicat	47
Dr. Hutton	38

Mr. Loyd's Experiments to Ascertain the Effect of Tensile Strain on Bars of Wrought Iron.

These experiments were made by Mr. Thomas Loyd, Inspector of Machinery at Woolwich Dockyard, to determine the tensile strength of S. C. crown bar iron, a well-known and highly-esteemed variety.

These experiments were made on bars 5 ft. in length, cut out of the middle of long bars. Forty of these bars were broken by weights which varied from 29·75 tons per sq. in. up to 34·25, the mean breaking weight being 32·84 tons. The ultimate elongation of 20 bars was taken after the fracture, and this varied from 7·5 in. up to 10·61, the mean being 9·09 in. for lengths of 5 ft. or 10-66ths of the whole length. The elongation of 20 bars was also taken when loaded with a weight of 25 tons, which was assumed as 3-4ths of their breaking weight. This elongation varied from 1·12 to 2·18 in. in 5 ft., the mean elongation being 1·64, or about 1-36th of the whole length.

I have myself experimented on King and Queen scrap iron, the manufacture of Howard and Ravenhill, which only extended $\frac{1}{63}$ part of its length with a weight of 24·35 tons per square inch. Another specimen of the same iron extended $\frac{1}{19}$ part of the length with $25\frac{1}{4}$ tons per square inch. Iron denominated best scrap, with the brand S. H. Crown, was extended $\frac{1}{160}$ part of its length with a weight of 16·1 tons; and an inferior iron, called Page and Son's Crown Scrap, broke with 20·92 tons per square inch, the ultimate elongation being $\frac{1}{21}$.

Machines for Experimenting on Tensile Strain.

These experiments are seldom made by means of direct weight, but commonly either with a lever or with the hydrostatic press.

Fig. 27 shows the lever machine used by Mr. Fairbairn for his experiments on boiler plates.

A is the fulcrum of the lever, which passes through a rectangular loop, B, suspended by strong shackles from the lower extremity of the specimen E, F. This specimen is hung on the cross-bar, D, by rings and shackles. B, C, is the long area of the lever, at the end of which the necessary weights are suspended to produce the required tension on the bar. As the end, C, of the lever is depressed, the point, B, comes down in a corresponding degree till the specimen, E, F, is elongated to the breaking

point. The power of this lever is of course in proportion to the lengths, A B and A C, or about 1 to 7. Hence, one ton in the further seale produces a tension at B = 7 tons.

The hydrostatic press used for experiments on tension is frequently of the same description as that used for testing chain cables. A first-rate machine of this description may be seen at Messrs. Mitcheson's chain-cable testing works, near the Commercial Docks.

Fig 28 is a sketch of this press, which will show the mode in which it is used. A, is the large piston or solid plunger, $10\frac{1}{2}$ in. in diameter, which is forced by the pressure of the water in the direction of the arrow; *g*, is the piston-rod working through a stuffing-box, and attached to strong hooks and shackles for holding either a chain cable or any specimen of wrought iron to be experimented upon. The other end of the specimen, whether a piece of bar or chain, is attached by shackles to an enormously strong cable, which will resist a pressure of 60 or 70 tons, and which is firmly seeured at the further extremity.

The water is pumped into the cylinder through the copper pipe *a*, the pumping power being either worked by a steam engine or by manual labour; *b* is an accurately fitted plug, or small plunger, $\frac{7}{8}$ of an inch in diameter, which works in the side of the large cylinder, and is of course subject to the same pressure per square inch as the large piston, A. *c* is the lever, the fulerum of which is at *e*, and the length from *c* to *f* is 105 in., while *e* to *b* is $4\frac{1}{4}$ in. It is evident when the water is forced into the large cylinder, against the piston, A, a proportionate force is exerted against the plug, *b*, which acts on the short arm of the lever, and tends to balance the weights placed in the scale, *d*. The power gained is, first, that of the ratio between the squares of the two pistons, less the square of *g*, the piston-rod; and, secondly, this power has to be multiplied by the ratio between *e b* and *e f*.

Now, the diameter of $a = 10\frac{1}{2}$ in.
" $g = 4$ "
" $b = \frac{7}{8}$ "

Then, $\frac{(10\frac{1}{2})^2 - 4^2}{(\frac{7}{8})^2} = \frac{110{\cdot}25 - 16}{{\cdot}7656} = 123$; that is, the pressure on the piston, A, is 123 times greater than on the plunger, *b*. The gain by leverage is equal to $\frac{105}{4{\cdot}25} = 24{\cdot}8$. Then, $123 \times 24{\cdot}8 = 3038$; so that every pound weight plaeed in the scale at *d* indieates a pressure on the piston, A, = 3,038 lbs. at the moment when the end, *f*, of the lever is raised.

The whole formula for power may be more readily expressed thus:—

$$\frac{(10{\cdot}5)^2 - 4^2 \times 105}{{\cdot}7656 \times 4{\cdot}25} = 3041 \text{ lbs.} = 27 \text{ cwt. } 17 \text{ lbs.},$$

the pressure on A, or tension on the specimen, represented by each lb. weight in the scale at *d*.

Also, $\frac{2240 \times 16}{3041} = 11{\cdot}75$ oz., the weight in the scale which represents 1 ton pressure on the piston, A.

It will be readily seen how small a weight in the scale will produee a very great tension in this powerful machine: for instauce, 56 lbs., or half a hundred weight, will produce a tension of $56 \times 27 = 1{,}512$ cwt., or more than 75 tons; a strain or test which is not unfrequently applied to chain cables.

The formula which has been given for the extension of cast iron may be simplified for practical purposes within the limits of 6 or 7 tons per square inch, which, as we have seen, is the highest tensile strain that cast iron is capable of bearing. Thus, the extension for cast iron may be taken at about $\frac{1}{5450}$ part of the length for each ton per square inch; henee, for cast iron, we have $e' = {\cdot}00018\, l$, or $2\frac{1}{4}$ times ${\cdot}00008\, l$, the extension for wrought iron.

INSTITUTION OF CIVIL ENGINEERS.

January 12, 1858.

JOSEPH LOCKE, Esq., M.P., President, in the Chair.

THE proceedings of the evening were commenced by an Address from the President, on taking the chair for the first time since his election.

He noticed the fact of his having been called unexpectedly to fulfil the duties of President; his views of the first obligation—the Address—being more than a formality; and the annually increasing difficulty of finding new topics.

He proposed to confine his observations to one portion of professional duties with which circumstances had induced personal experience—the principles and character of the French railway system; and this he was encouraged to attempt in consequence of the late President—Mr. Robert Stephenson—having so fully discussed the main features of English railways, the origin, progress, and results of which were in many respects strikingly dissimilar to those of the Continent.

The practical results in England had been immense convenience and advantage to the public who used, and inadequate profit to those who had constructed, the railways; but in France the terms were reversed—the capital invested yielding a good profit, whilst the service to the public, although far in advance of all former means of conveyance, was still very limited.

In contrasting the systems, it would be shown that the real difference was greater than was apparent on a mere comparison of per-centage of income and profit; and that other things being equal, the advantage might be assumed to be in favour of England in all that was essential to the success of improved communication; and all circumstances being considered, the result should have been a higher rate of profit from railways in England than in France.

The essential characteristics of the French system, were, first, the determination by the State of the locality and direction of the main arterial lines of railway; and secondly, the process which the State, whilst adhering to its general rule, of absolute control over the selection of lines, had thought proper to employ, in order to obtain the desired progress in their construction.

The terms of concession had undergone great variation at different periods of the French railway history, but the system had been invariably sustained by the conservative operation of the ruling principle, and it was this which had given to the French system the main advantage over the more liberal course pursued in England. In the former case, the State absolutely determined the lines, favouring exclusively main arterial communications, and forbidding competition within special districts; whilst in the latter case the principles of competition had been not only admitted, but encouraged, with ruinous results to the shareholders.

In the first projection of a line in France, the English system of Parliamentary notices, deposit of plans, standing orders, committees, examinations, &c., were entirely dispensed with. The Government took the initiative in everything relating to public works. All railways must originate with, or be sanctioned by the State, and when a ministerial decision was pronounced in favour of the "public utility" of any line, the Minister of Public Works was authorised to satisfy himself of the "*bonâ fides*" and ability of the several competitors, to select the most eligible offer, and to enter into a preliminary treaty, which, when approved by the Government and the Chamber, or Senate, was ultimately signed by the Emperor, and became law. The "cahier des charges," fixing the conditions of the concession and the powers of the Company, was settled at the same time. The Government furnished such plans, sections, and other data relative to the line, as were in its possession, and the railway was then laid out. The "cahier des charges" allowed considerable latitude in the selection of the line. The preliminary survey, or "avant projet," containing a general description of the line, with details of the curves, gradients, &c., was presented by the Company to the Minister of Public Works, who, after consulting with the "Conseil des Pouts et Chaussées," signified his approval through the Préfet to the Company.

Meanwhile plans and references were prepared for each "commune," or parish, showing how the roads, rivers, &c., were proposed to be crossed, or deviated, which, being sent to the Préfet, were by him communicated to the Mayors of the Communes. Their receipt was notified on the doors of the church and of the Mairie, and by the beat of drum, and they remained during eight days for inspection by all who were interested. A "procès-verbal" was then drawn up of all objections, for submission to the Préfet, by whom a commission was named, composed of members of the Conseil-Général of the Department, the Mayors of the Communes interested, and the Engineer of the Company. The report from this commission was sent by the Préfet to the Government Engineers, appointed to report on the nature and fitness of the works, and to superintend the fulfilment of the clauses of the concession. The report of these engineers being then sent, with all plans, &c., to the Minister of Public Works, his final decision was obtained. The Préfet then made his "arètè de cessibilité," declaring transferrable for public utility the parcels of land marked for expropriation. The Procureur Impérial of the civil court of each district, then required from the tribunal orders of expropriation. The civil tribunal examined whether all the formalities had been rigorously fulfilled, decreed the expropriation, and from that moment all the houses, lands, &c., became the property of the Company, by whom the amount of the indemnity, settled by agreement or by jury, must be paid.

The time occupied in these preliminaries varied from six to twelve months, but although tedious, the process was not expensive, and it exempted the Company from the doubtful and onerous charge to companies in England, of getting a Bill through Parliament at a cost which ever after remained a dead-weight on the Company.

The first railway concession granted in France was in 1823, for a line twelve miles in length, from the coal-fields at St. Etienue to Andrézieux, on the Loire; in 1826 and 1828 other lines from the same district to Roanne and to Lyons, were granted; these were all constructed entirely at the expense of the promoters. In 1838, the lines from Strasbourg to Basle—Paris to Havre—Paris to Orleans, and Lille to Dunkerque, were conceded to private companies, but the funds not being provided the concessions partially lapsed. In 1842 a law was past authorising the State to construct the railways up to "formation level," and to let for a term of years the working of the lines to companies, who would provide the permanent way, engines, and rolling stock. This had the effect of giving considerable impulse to the railway system, and induced the importation of foreign capital. The law was subsequently modified by the State granting "subventions" of money, instead of constructing the earthworks, &c. Up to 1842 the concessions granted were under 600 miles, but in that year alone upwards of 1,400 miles were sanctioued. Among these were—

Paris to Lille and Valenciennes.
Rouen to Havre.
Paris to Strasbourg.
Paris to Lyons.
Avignon to Marseilles.
Orleans to Vierzon and Bourges.
Orleans to Bordeaux.

Nearly all the concessions since 1842 had been based on the law of that year, or were in the modified form of giving a "subvention" in lieu of works, with a minimum guaranteed interest of 4 per cent., and an extension of term to 99

years. To this combination of pecuniary aid, with a guarantee of interest, may be ascribed the rapid increase in the development of the French railway system since 1842. It was remarkable that this timely aid, granted by the State, had been thoroughly successful, and in no case had the guarantee for interest ever been claimed; thus the object had been completely fulfilled, without any loss to the State.

The financial condition of the French railways was exhibited in the following table :—

	Private Capital.	Contributions of the State.	Length of lines conceded.	Length of lines opened.
	£	£	Miles.	Miles.
From 1823 to 1842 ..	7,000,000	120,000	550	—
,, 1842 to 1847 ..	17,000,000	9,280,000	2,250	1,156
,, 1848 to 1851 ..	8,000,000	12,000,000	—	—
,, 1852 to 1854 ..	29,240,000	3,840,000	5,770	2,900
,, 1855 to 1856 ..	35,520,000	1,200,000	7,030	4,060
	£96,760,000	26,440,000		
Still to complete	41,200,000	9,200,000		
	£137,960,000	35,640,000		
	35,640,000			
Total	£173,600,000			

The total cost, therefore, of the 7,030 miles conceded was estimated at about £24,600 per mile, of which £19,600 was to be provided by the companies, and £5,000 by the State; what the actual cost would ultimately be was not yet ascertainable.

The fluctuations in the amount granted at different periods by the State, were shown to have arisen from the necessary modifications of the law—the abandoning the reversionary interest in the railways—the guaranteeing 4 per cent. interest, and the remission of the right to a share in the profits after a certain dividend had been paid. The capital guaranteed by the State had, in 1855, reached nearly sixty millions, applicable chiefly to six principal lines, of an aggregate length of 5,200 miles.

The right of participation, which had originally applied to nearly all the railways founded on the law of 1842, had been generally abandoned; so that it now only applied to five companies, owning 3,500 miles of railway.

Thus it was shown that from the commencement the railways had in some shape always received a certain amount of direct assistance from the State, in addition to the protection afforded whilst exercising a general principle of control.

The most important element in the finance of French railways was the proportion which the share capital bore to the amount raised on obligations or bonds. In this respect the French system differed essentially from that of the English companies.

In the whole of the capital engaged to be provided by the French companies, amounting, in 1856, to £137,960,000, there was then £50,000,000 in shares; or only about 37 per cent.; whilst the remaining 63 per cent. had to be raised on obligations or bonds. Of this several marked instances were given.

The effect of this mode of providing the funds was evident on examining the *net* receipts of the French railways from 1841 to 1854, and the per-centage of dividend which had resulted.

The per-centage paid on the whole capital expended—

In 1841 .... .. was .... 3·11 per cent.
,, 1847 .... ,, ... 6·30 ,,
,, 1854 .... ,, ... 6·58 ,,

By the operation of subventions the rate paid to the companies—

In 1841 .... was .... 3·11 per cent.
,, 1847 .... ,, ... 7·17 ,,
,, 1854 .... ,, ... 9·0 ,,

Thus the State assistance, at the latter period, gave a benefit of 2·42 per cent. on the whole of the remaining capital.

The largest amount of that capital was, however, raised on loan at a fixed rate of interest, and thus, according as the dividend on the whole capital varied from the interest paid to the bondholders, a profit or a loss would accrue to the Company. In order, then, to a just comparison with English railways, the per-centage of net income must, in both cases, be taken on the whole capital raised—by which the per-centage would be considerably reduced on the French side and raised on the English; the rate of interest on loans being taken at 5 per cent. on both sides. It followed, then, that it depended on the ratio of net profit to the whole capital expended, whether any portion of it, raised by loans at a fixed rate of interest, would increase or lower the rate of dividend on the remaining portion.

Taking two railways, each having cost a million, one producing a net profit of 4 per cent., and the other of 8 per cent: if the first had borrowed half its capital at 5 per cent., the sum left for dividend on the half-million in shares was reduced to £15,000, or 3 per cent.; whilst the second, by also borrowing half its capital at 5 per cent., would raise its dividend on its half-million in shares to £55,000, or 11 per cent.

Assuming the same premises, and the limitation of borrowing to be about one-third of the capital, as in England, and in the other case two-thirds, as in France, the operation would be that in the former the share dividend would be reduced to 3½ per cent., and in the latter case it would be raised to 14 per cent.

It thus appeared that the decisive element in both was the ratio of net profit to the whole capital spent in a given undertaking; and that the reason of French dividends being augmented by borrowing so largely, was solely because the rate of profit, earned on the entire cost, was in excess of the current rate of interest; whilst the dividends on English railways were impaired by the same process, because the conditions were reversed.

It was estimated that the profit realised by French companies, from their system of borrowing so largely, amounted to upwards of 3 per cent. on the whole of their share capital; and the fact was instanced that, as between 1854 and 1857 the average annual dividends paid by some railways were :—

The Nord .... 14 per cent.
,, L'Est .... 14 ,,
,, L'Ouest .... 10 ,,
,, Paris to Lyons .... 16 ,,
,, Orleans .... 16 ,,
,, Lyons to the Mediterranean in 1855 17 ,,
,, ,, ,, in 1857 23 ,,

The system of gradually extinguishing the capital by "amortissement," spreading it over 99 years at the rate of about one-eighth or one-fourth per cent., was then described. The final result of the comparative examination was, although the true scale of profits on French railways was not quite so high as had been represented, it still was greater than was exhibited by English lines.

A comparison of the expense of construction of the French and English railways exhibited an unfavourable picture of the latter; the estimated cost of the former being about £24,688 per mile, whilst that of the latter was about £31,690 per mile.

The causes which tended to swell the expenses of English railways had been fully stated by Mr. Robert Stephenson, the late President, in his address from the chair; from many of them, such as the Parliamentary proceedings, and the effects of the rivalry of other lines in the respective districts, the French railways were exempted. The physical features of the country rendering for the most part unnecessary the viaducts, tunnels, and other expensive works, which distinguished the English railways, contributed also much to reduce the cost of construction.

One fertile source of expense in England had been the duplication of lines and stations in many of the large towns, and the premiums paid by timid directors to projectors of rival lines, in order to buy up and extinguish opposition.

Of this several glaring instances were given in the cases of the Trent Valley, the Leeds and Bradford, the Oxford and Birmingham, the Birmingham, Wolverhampton, and Dudley, the Richmond, and other railways. If to these causes were added the exactions of landowners, and the enormous expenses of Parliamentary inquiries, the dead weight of primary debt on the English lines could be easily accounted for, and from all these the French lines were exempted.

The cost of railways would probably be diminished in future in England, whilst in France they had not yet reached the culminating point, as between the years 1841 and 1854 the cost had gradually increased from £18,600 per mile to £26,664 per mile.

In return for its aid and protection from rivalry, the French Government had secured the gratuitous conveyance of the mails, and had laid on a tax of ten per cent. on passengers, and on first-class goods, which two items yielded 5 per cent. on the sum of £36,000,000 of subventions. Low tariffs were also fixed for soldiers, sailors, prisoners, paupers, &c.; participation, in some cases, after certain division of profits; and the possession, at the end of the concessions, *of all the railways* in France. After all these considerations the French system appeared to have reconciled the interests both of the promoters and of the State, as whilst the former had obtained a liberal return for their outlay, the latter had secured substantial public benefits, for the aid they had given; in short, the railway interest in France had not, as in England, been made a victim of public exigencies and of private cupidity.

The limited service for the public on the French lines was then noticed, and it was shown that, as compared with the English system, it was deficient. This induced economy, and influenced the profits, but still the cost of fuel, and of all that belonged to the locomotive power was greater than in England.

Referring to the absolute engineering construction of French railways, there was little to occupy attention, as they were almost entirely imitations of those which had been already completed in England, where the experiments were tried, and where both the engineers and the operatives had to acquire their experience practically.

Several instances were given by the President of his own personal experience in the construction and maintenance of French railways. He found it, at the beginning, indispensable to secure the co-operation of experienced contractors, and this induced the introduction by Messrs. Brassey and McKenzie of the machinery and skilled labour at their command, in order eventually to instruct others in similar works. The success which attended their efforts, particularly those of Mr. Brassey, not only in France, but in nearly every part of the globe, fully justified the importation of Englishmen to France for the intended purposes.

One of the most striking consequences was the introduction of the class of "navvies," whose appearance, habits, manners, and mode of work were equally novel to the French; yet they soon became perfectly at home, and inspired such confidence among the native labourers, that they would not undertake any task work unless the gang was headed by a "navvie." The force of the example of these men was now manifest, in the improved style of work on the French lines, so that there was now little, if any, difference in the relative values of the labour obtained from each. Thus the introduction of English labour, far from being a grievance, as was assumed, had, as previously in the case of the iron trade and machinery manufacture, considerably improved the condition of the French working class.

In 1840 there was no important establishment where the locomotives could be made, or even be repaired; this induced Mr. Locke to construct workshops

at Rouen, and in this he engaged the assistance of Mr. Buddicom, who constructed, at fixed prices, all the engines, carriages, waggons, and other rolling stock, required for the Paris and Rouen Railway, and subsequently agreed to repair and maintain them at a fixed rate per kilomètre. The experiment was eminently successful, and Mr. Buddicom's operations had been extended to other lines, with great credit to himself and advantage to the railway companies.

Large manufactories of engines had since been created, equal to the supply of the wants of the country, and English mechanics were now scarcely seen on any other than the Rouen Railway. Neither the precision of manufacture nor of manipulation had, however, yet reached the English standard; nor had the economy of working been brought so low, notwithstanding the speed being lower, the wages being less, and the trains less frequent, better filled, and carrying less dead weight.

In absolute construction there was little to remark. The masonry was more lavish in quantity; the slopes of cuttings were not flat enough, and were frequently pitched with stone; the rails were chiefly the double-headed parallel, as first used on the Grand Junction Line, in England; the gauge was identical with the English standard, and uniform throughout the country; and the permanent way generally differed but little from the majority of the British line.

One national peculiarity was the employment of females in the booking offices, level crossings, &c., and other departments, to the duties of which they were found well adapted.

In the conduct of works there was a manifest difference between the proceedings of the English and the French engineers; the former personally examined the ground throughout, planned the works, superintended the execution, constantly inspected the progress, determined every proceeding, met every difficulty, and assumed the responsibility of the entire works. The French practice was in many cases the reverse; the engineer devised his scheme in his study, relying upon the reports and surveys supplied by the Government departments, or his own subordinates, upon whose information he continued to rely, and to advise rather than to direct, even in cases of exigency. The system, commencing with the chief, descended through all grades, each depending in some degree upon the report of his subordinates, so that the chief frequently acted upon information really originating with subalterns possessing very moderate qualifications. There was in this a great appearance of organisation,—on paper it was methodical and imposing,—but it could hardly be deemed an efficient substitute for the less formal, but more direct process of individual supervision, by which the Engineer was brought into personal relation with the difficulties with which he has to contend and the forces he has to wield.

Another peculiarity of the Continental system was the detrimental influence exercised by the Government Engineers of the "Ponts et Chaussées," as "controleurs," whose presence affected the railway system by their frequent demands or suggestions, which, although of no legal force, were generally submitted to. The President bore testimony to the consideration with which he had been individually treated in his continental undertakings, but even that could not blind him to the defects of the system.

In summing up, it was observed, that the difference in estimated cost per mile of the lines hitherto conceded, or made in France, as compared with those in England, might be taken at £5,000 to £7,000. To this must be added in the French promoter's favour the £5,000 per mile furnished by the State. If, however, from the English rate, were taken the outlay solely due to disadvantages from which the French were exempted, the difference in favour of the latter, making every allowance for the more even surface of their country, would be considerably reduced.

A map of the French railways, showed them nearly all to be in the nature of leading communications; each serving an important district, and itself free from the pressure of competing rivals. The advantage of the French system really consisted more in the class of lines on which the money had been spent, and in the assistance given in raising that money, than in the cost per mile at which the railways had been made. These were the two cardinal points on which the greater prosperity of the system turned; for in reality there were not any special circumstances, excepting giving a more limited amount of accommodation to the public, that would explain its superiority; and that exception was perhaps balanced by the greater cost of working supplies, the higher passenger tax, the 10 per cent. rate on a portion of the merchandise receipts, and the conveyance of the mails, &c., gratis.

In short, it appeared, that the real source of the present good fortune of the French railways lay in the favourable treatment they received from the State. The French Government certainly did strongly control the railways, but they also liberally fostered that kind of enterprise; whilst the English Legislature, unable to guide, had suffered, if not encouraged, hostile, or selfish interests, to encumber and pervert the legitimate objects of the lines. In fact, the contrast between the railways of the two countries was very striking. In France, led and guarded by the sovereign power, method was observable, and success was apparently attained; whilst in England confusion was paramount, and the railway interest, ungoverned and undefended, was left to the chances of competition, abandoned to every species of attack and "black-mail," and was only conscious of authority in the shape of exactions. This view suggested many grave and difficult considerations, some of which fell rather within the province of the Philosopher and Statesman, than of the Civil Engineer.

The President apologised for having dwelt so much at length upon the financial part of the subject; but he contended that the whole question practically resolved itself into a control of the application of capital to a given purpose; which, far from being foreign to the province of the Civil Engineer, must, on the contrary, be deemed a most important part of it, which should never be lost sight of, from the beginning of his studies to the close of his professional career.

For the problem proposed to practical science was, not merely the execution of certain works, but rather their arrangement and construction, in a manner calculated to realise the objects in which they originated. The proposition, then, being not simply that railways should be constructed, but that they should be so made, as, whilst conferring a public benefit, they should produce, for their proprietors, the benefits in expectation of which funds for their construction had been contributed. The profitable effect of capital directed to a given object, in the hope of profit, was thus a main element of the subject, on which the modern Engineer had to exert his skill and judgment. The practical science of the present day, as enlisted in the service of monied enterprise, must necessarily confess itself at fault, if by any glaring defect in its exercise, that enterprise did not reap its fair reward. It was obvious, that when the employment of science, by wealth, was mainly actuated by the stimulus of gain, if the inducement ceased, the occupation would be at an end. Public works would no longer be attempted, where experience showed that, instead of profit, ruin must ensue. Confidence would give way to distrust,—capital would seek its harvest in other channels, and the cause of past disappointment would become the object of prejudice, which years of subsequent profit would not entirely eradicate.

In every view, then, the successful financial result of the combination of science and capital was the important feature, and the due appreciation of this view really concerned the Engineer, no less than the Statesman, or the Capitalist.

The Address was received with much applause; and it was resolved that it should be printed and circulated with the Minutes of Proceedings.

ON THE RELATIVE EVAPORATING POWER OF BRASS AND IRON TUBES.

By Mr. GEORGE TOSH, of Maryport.*

BRASS and iron tubes for locomotive, marine, and other boilers, having been so extensively employed, their respective properties and defects are generally known under the various trying circumstances and situations in which they have been used; but, as there is still a difference of opinion existing on the subject of their relative advantages, the following experiments were made by the writer with great care, for the purpose of arriving at the truth, if possible, and for his guidance, as to the relative evaporating power of brass and iron tubes.

The writer having had the superintendence of locomotive and other engines for a number of years, has used considerable numbers of both brass and iron tubes, in several cases with apparently equal success; the former having generally been preferred for locomotive engines working at a high pressure, because there is less difficulty in keeping them fast in the tube plates, and the adhesion of the deposit from bad water is not so great on brass as on iron; and it is well known that when iron tubes once become leaky, their ends are speedily wasted, and cannot afterwards be depended upon. Although brass tubes are generally adopted by the railway engineers of England, in preference to iron, there are companies using iron ones largely at the present time; and some engineers express their surprise at any other material than iron being used for that purpose.

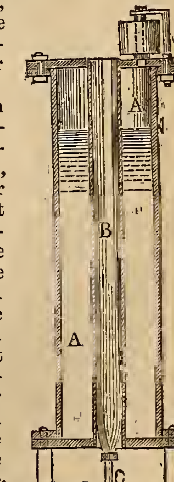


Fig 1—Vertical Section.

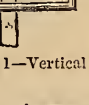


Fig 2—Transverse Section.

Some time ago the writer's attention was drawn to a Paper on this subject in the "American Railroad Journal," from which the following is an extract:—"It has been for many years, and still is, the practice of scientific men to recommend copper in preference to wrought iron for boilers to heat water or other fluids, on the ground of the superior conducting power of the former over the latter metal; and it will doubtless appear strange to many that a doctrine so well established should now meet with the most unqualified dissent. The superior conducting power of copper over iron admits of no doubt; and yet, upon this correct basis, has been raised a fallacious doctrine, resulting in a great waste of money by the use of copper instead of iron in the boilers of steam-boats and locomotives. Iron absorbs heat so much more rapidly than copper, that many explosions have occurred which would not had copper been used;—although this is admitted, it is too bad to praise copper for this also, that it will not let a boiler blow up, when, everything considered, it ought to blow up, if a good fire and a good medium through which to convey its caloric into the water have any virtue in them. Copper cannot be a good medium through which to raise steam and a bad one to blow up with; yet the argument means this if anything: nevertheless, it is admitted that this is not the ground on which any dependence can be placed, because, whenever such a catastrophe has happened, it has arisen from a defective ar-

* Paper read before the Institution of Mechanical Engineers.

rangement of the boiler; in fact, the greatest defect that can properly occur in the designing of a boiler, the want of a complete and thorough circulation of the water within it, on precisely the same principle as the circulation of hot water in pipes for the purpose of warming buildings."

As these views are so directly at variance with the general views of the engineers of this country, the writer determined on making experiments for himself, being unable to obtain any information on the subject that could be relied on. Two vertical boilers, A, Figs. 1 and 2, were therefore constructed of equal dimensions, 6 in. diameter and 2 ft. long, with a single tube, B, in the centre of each, 2 in. external diameter and No. 14 wire gauge thickness, of brass and iron respectively. The two boilers were filled with water of the same quality and of the same temperature, and alternately placed upon a stand in the same position over a gas flame, C; they were each exposed to the action of the gas for the same length of time, which was equivalent to the same quantity of fuel being consumed in each case; and the height of water was carefully gauged after each experiment as soon as ebullition had ceased. The experiments were first made during the day, and afterwards at night, at times when there was the least probability of a change of pressure in the gas-pipes during the period of the experiment, by lighting or extinguishing the gas in the town.

The annexed Table shows the results of eight experiments made with the above apparatus, the quantity of water evaporated being measured by the number of inches that the level of the water in the boiler is lowered in each experiment: the average shows that 2 lbs., cwts., or tons of fuel, with brass tubes, evaporate the same quantity of water as $2\frac{1}{2}$ lbs., cwts., or tons of the same fuel with iron tubes; hence the evaporating power of brass is to that of iron as 125 : 100, or brass will evaporate about 25 per eent. more water than iron with the same quantity of fuel.

Table *of Experiments on the Relative Evaporating Power of Brass and Iron Tubes.*

Description of Tubes.	Quantity of Water Evaporated.								
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Average.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Brass	2	$\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{8}$	3	$3\frac{1}{4}$	$3\frac{1}{4}$	3	$2\frac{1}{2}$
Iron	$1\frac{5}{8}$	$\frac{3}{8}$	2	$1\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{1}{4}$	2

Further experiments were made with brass and copper tubes, and copper was found to be fully as much superior to brass as brass is to iron; so that the evaporating power of copper is to that of iron as 156 : 100, or copper will evaporate about 56 per cent. more water than iron with the same quantity of fuel.

Mr. McConnell inquired whether the two sets of tubes used in the experiments were exactly the same gauge in thickness, since a little difference in that respect would sensibly affect the result of such experiments, as they were on a small scale compared with actual practice.

Mr. Tosh replied that the tubes were gauged as exactly as possible, special care being taken to make sure of having the same thickness in all; the water was also gauged when cold in each case, to avoid any error from expansion of the water; and from the precautions taken to prevent sources of error in the experiments, the results obtained could be attributed only to the different conducting power of the two metals.

Mr. W. B. Johnson asked how the uniform pressure of the gas throughout all the comparative experiments had been ensured, and whether a meter had been used to measure the consumption exactly, as the quantity consumed might vary so much with ordinary variations of pressure as to affect the results materially.

Mr. Tosh said the consumption of gas had been regulated only by having the same burner burning for the same length of time. Measuring the quantity by a meter would certainly have been more complete; but he thought from the precautions taken there could not be any perceptible error from that cause. Application was made to the gas works at the time of the experiments, and a uniform pressure ensured during the time they were in progress, which was only half an hour on each occasion.

Mr. W. B. Johnson was much surprised at the result obtained from the experiments, as it was quite different from the results of his own experience, and he had been led to the conclusion that there was no appreciable difference between the two metals in effective evaporating power. He had had a good opportunity of comparing them on a large scale in two boilers of 160 H.P. each, which had been made exactly alike, except that one had iron and the other copper tubes; and the result of their working was found to be so equal that no difference could be decided upon between them. He inquired whether, in the experiments described, each pair of experiments that were compared together were made at the same time.

Mr. Tosh said that each pair of experiments were made not at the same time, but immediately following each other; first the brass tubes, and then the iron tubes, forming the pair for comparison; and then the same alternation again. He was now preparing for carrying out the experiments on a large scale, and hoped soon to obtain more extensive results; in all the experiments that he had tried, iron and brass only were employed, not copper, as his object was to ascertain the relative value of tubes made of iron and brass.

Professor Rankine observed that a number of experiments had been tried many years ago by Mr. James R. Napier with experimental boilers of iron and copper of various thicknesses heated over the same gas flame, and he found only a small difference in evaporating power of about 1-20th or 1-30th in favour of the copper. In all experiments of the kind the state of the heating surface was important, whether smooth or rough, and whether perfectly clean or incrusted to any extent. The effective evaporating result or transmission of heat through the metal depended on three properties:—1st, the resistance of the first surface to absorption of heat from the heated air and gases; 2nd, the resistance of the internal particles of the metal to the conduction of heat; and 3rd, the resistance of the second surface to giving off heat to the water. Those three properties were not possessed in the same proportion by different bodies; the resistance to internal conduction was less in copper than in iron, but the resistance of the surface was greater in copper. Peclet found, in one of the best series of experiments on the subject yet made, that when the surface became dull the transmission of heat through all metals was very nearly the same.

Mr. Siemens thought the difference was so great and so uniform in the results obtained from the experiments described in the Paper, that it could not be accounted for by any unobserved variation in the quantity of the gas consumed, as that would not have caused a marked difference all on one side; he thought the experiments did not afford a true criterion of what brass and iron tubes would do in a locomotive boiler, as the mode of action and the currents of heated gases differed so much in these vertical tubes heated by gas flames below, from those in the numerous horizontal tubes of a locomotive boiler. With the small gas flame, the air before coming in contact with the sides of the tube might be cooled down nearly to the temperature of the water, and the relative effect of resistance at the surface of the metal, and in the interior would be materially altered, a low temperature leaving but little difference between the two bodies to overcome the resistance; the proportion of air carried through the two sets of tubes might also be varied by the effect of the temperature on the draft. The brass tubes might gain an advantage from their smoother surface causing less adhesion of the minute bubbles of steam during slow ebullition, though that circumstance would not apply in rapid ebullition. The internal conducting power of copper had been proved by Dr. Ure's experiments to be so good that the thickness of the metal did not perceptibly retard the rate of evaporation, though with iron the result was decidedly affected by the thickness.

Mr. R. Roberts thought the trial of the converse experiment of the time of cooling from the boiling point in two similar vessels of copper and of iron might be serviceable. He had found that the thickness of metal with copper as well as with iron materially affected the evaporating power, and that the thickness of plate when considerable much retarded the passage of heat, and caused the metal to be injured by overheating, the heat not being carried off by the water fast enough; he had found brass tubes of No. 18 wire gauge last considerably longer than others of No. 14 wire gauge under the same circumstances, and supposed that was owing to their transmitting the heat to the water more quickly, and therefore the metal suffered less than in the thick tubes.

Mr. Hawkes suggested the trial of corresponding experiments with tubes made of brass, copper, and iron, the lengths of which should be inversely as the conducting power of the metal.

Mr. Craig thought the temperature should be also tried in the experiments by a thermometer put into the tubes; the circumstances were certainly different in the experiments from those in locomotive boilers, in consequence of the exposure of the experimental tubes to currents of air. He had not found much difference in practice between brass and iron tubes in locomotive boilers, and did not know any definite result in favour of either of them as to evaporating power.

Mr. Henry Maudslay observed that, in steam-engine boilers, particularly marine and stationary, there were often other reasons affecting the question of the use of copper or iron, besides merely the conducting power for heat; such as durability under exposure to rusting or corrosion, and the relative accumulation of incrustation. He had known a case of nine marine boilers ordered for Naples, of copper, to allow of laying up without suffering from rust; for iron boilers were sometimes seriously damaged in eighteen months, whilst copper boilers were not affected; and this became then a more important question than original cost or conducting power.

DESCRIPTION OF AN IMPROVED CONSTRUCTION OF UPRIGHT STEAM BOILERS.*

By Mr. Thomas Dunn, of Manchester.

The early forms of upright boilers, with the chimney placed through the crown of the boiler, or in the side near the top, allowed a great portion of the heat to pass into the chimney flues. An attempt was made some years ago to retain this heat by placing tubes of small diameter in the crown of those boilers; this, however, caused a liability to the collection of dirt and sediment on the top of the tube plates next the fire, causing them to become burned away, as also the ends of the tubes.

These objections led the writer to endeavour to produce a boiler which should retain the heat without the use of tubes, and should also cause a mixture of the gases for the purpose of burning the smoke. This boiler is shown in Figs. 1 to 4.

Figs. 1 and 2 represent a vertical section and sectional plan of an improved upright boiler with two furnaces, A and B, the heat and gases from each furnace rising into the crown of the boiler, C, in which they meet and combine, the alternate working of the fires causing the flame from one fire to burn the smoke formed in the other, and *vice versâ;* the heated current then turns down through the space D, passing again through the water before entering into the chimney flue, E. Several of these boilers have been made and tested, and have proved in work very satisfactory. One of them has been at work nine months at the writer's works, which is of the following dimensions:—Diameter of outer shell, 4 ft. 6 in.; height from ground line to top of crown, 10 ft.; diameter of inner fire-box, 3 ft. 11 in.; width of down draught flue, D, 5 in. The whole of the fire-box and boiler is of Staffordshire iron, the outer shell being $\frac{3}{8}$ in. thick, and the inner fire-box and flue $\frac{7}{16}$ in. thick. The heating surface measures 145 sq. ft., and the fire-grate is $7\frac{3}{4}$ sq. ft. area. The flat water spaces forming the down draught are 3 in. wide, and stayed with screw stays 5 in. apart, similarly to a locomotive fire-box.

The following general results were obtained in a set of experiments made with this boiler, taking the mean of three days' working with each description of coal, the steam pressure being maintained at 65 lbs. per square inch throughout, and the temperature of the feed-water at 62° Fahr.:—5·90 lbs. of water were evaporated per lb. of coal, with best Lancashire coal, at 10s. per ton delivered, burning 16·48 lbs. per square foot of grate per hour; 4·38 lbs. of water were evaporated per lb. of coal, with Burgy or the refuse of coal pits, at 5s. 6d. per ton delivered, burning 20·90 lbs. per square foot of grate per hour. The outer shell of the boiler was not clothed, which caused a considerable loss of heat by radiation in the experiments.

After trying several of these boilers, the writer constructed one with a circular down draught flue, as shown in Figs. 3 and 4, for the purpose of saving the expense of stays. This plan did not give quite so much heating surface, but allowed rather more grate area, and the results of this boiler were found very similar to those of the former experiments. The fire in this boiler is not divided, as in Figs. 1 and 2, and the gases are therefore allowed to combine in the fire-box, F F.

This plan of boiler is well adapted for the interior of buildings, where dust and dirt from ordinary boilers would be an annoyance, as the ash-pits are below the surface of the floor, and are made to hold the accumulation of a week's ashes. No external iron chimneys or pipes being required, there is also less risk of accident by fire. The expense is not more than that of the ordinary upright boilers. These boilers have been proved with water pressure to 150 lbs. per square inch.

DUNN'S UPRIGHT STEAM BOILERS.

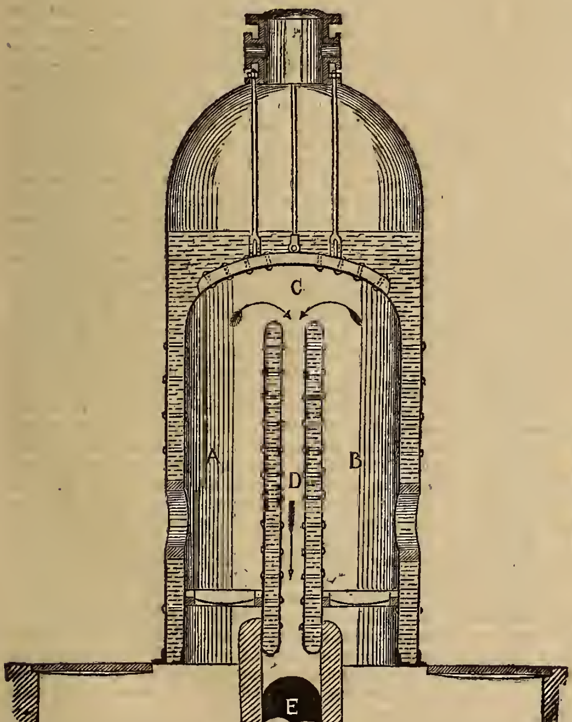


Fig. 1.—Veritcal Section.

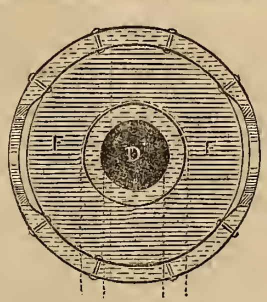


Fig. 2.—Sectional Plan.

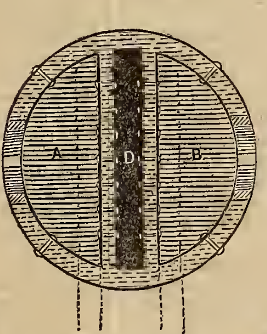


Fig. 4.—Sectional Plan.

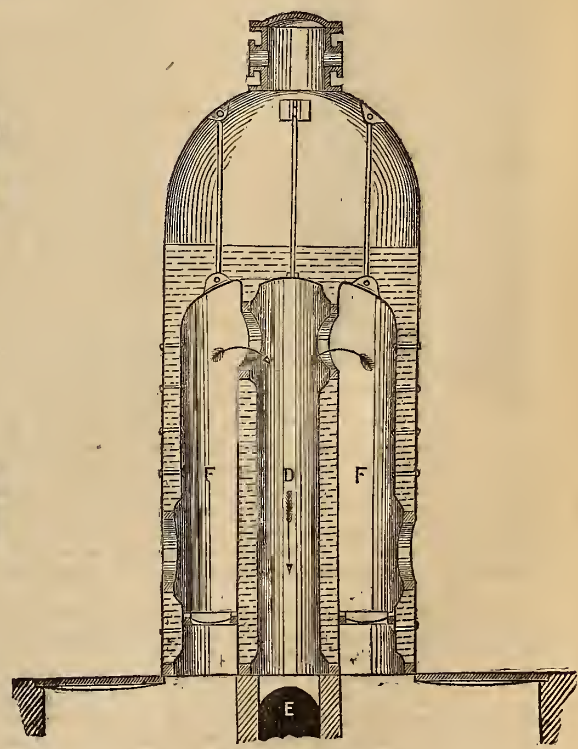


Fig. 3.—Vertical Section.

ON A NEW WATER CONNECTION BETWEEN LOCOMOTIVE ENGINES AND TENDERS.*

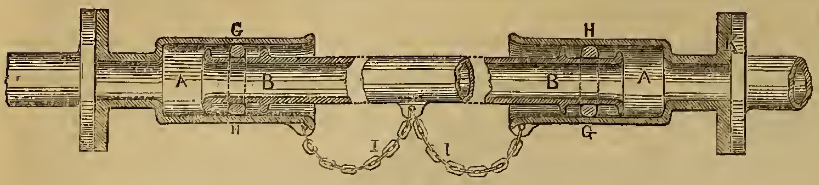
By Mr. James Fenton, of Low Moor.

Since the first introduction of the locomotive engine, now more than a quarter of a century ago, several plans have been adopted for connecting the feed pipes of the engine and tender, capable of resisting for a time, without leakage, the great wear that takes place in the ordinary course of running, which is accelerated by blowing steam from the boiler of the engine into the tender tank. All these plans, however, have been expensive, either in first cost, or to keep in repair, or both. Those most generally in use are the ball and socket pipes, and the flexible tubes or hose pipes. Other and more recent inventions have been tried, but the author believes they have not been attended with an amount of success sufficient to insure their general adoption. The ball and socket connections prove a continual source of annoyance and expense to all who have them in use on their locomotive stock; and the flexible tubes or hose pipes are scarcely less troublesome.

With the view of remedying this acknowledged defect in one of the details of the locomotive engine, the author's attention was directed to the subject, and the water connection described in the present Paper is the result.

* Papers read before the Institution of Mechanical Engineers.

Fig. 1 is a longitudinal section of the water connection, and Fig. 2



FEED PIPE CONNECTION.—Fig. 1.

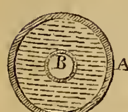


Fig. 2. Section at G, H.

a transverse section. Fig. 3 is a full sized section, showing the rolling packing ring.

A A are two cylinders of brass or iron, one of which is bolted in the usual manner to the feed-pipe of the engine, and the other to that of the tender; they are both bored out smooth and parallel. B B is a connecting tube of brass or iron, having the ends turned, the part from C to D, Fig. 3, being parallel, and that from D to E coned. The collars, F, are curved, as shown in the figure. G G are elastic rings of vulcanized india-rubber, which, when at work, roll between the cylinders, A A, and the connecting tube, B. I I are light chains used for the purpose of keeping the tube, B, in its proper position; they are each left slack to an extent of one-half the greatest amount of travel required between the engine and tender.

Fig. 3.—Section at C, full size.

The advantages which this arrangement appears to possess are its extreme simplicity, and consequent cheapness, both in first cost and current repair, and the great durability of the only wearing parts, the motion of the elastic rings when at work being a *rolling* instead of a *rubbing* action; also the absolute tightness of the joints when steam is blown from the boiler into the tender tank, as the elastic rings, G G, are then forced up the cones, D E, by the increased pressure, and are only prevented from being blown out by the collars, F, which are curved, as shown in Fig. 3, for the purpose of enabling the rings again readily to adjust themselves to their proper position when the pressure is removed, which they do as soon as the engine is put in motion.

The india-rubber rings, G, are made slightly larger than the space into which they fit, for the purpose of ensuring a thoroughly water-tight joint. The cylinders, A, are $3\frac{1}{16}$ in. inside diameter, and the tube, B, 2 in. outside diameter, as in the figure; the ring is made $3\frac{1}{8}$ in. outside diameter, and $1\frac{7}{8}$ in. inside diameter, the section of the ring being a circle $\frac{5}{8}$ in. diameter.

Should either of the tender valves get out of order on the journey, and it becomes necessary to stop the feed by other means, it is only requisite to slack back the bolts which hold the flanges, K, together, and introduce a piece of sheet iron or zinc between them of sufficient width to cover the orifice of the feed pipe. This simple and effectual mode of stopping the feed was suggested and adopted by Mr. Ramsbottom, of the London and North Western Railway, on which, as well as on several other lines of railway, this water connection has been in successful operation for several months.

ON THE MANUFACTURE OF PUDDLED OR WROUGHT STEEL, WITH AN ACCOUNT OF SOME OF THE USES TO WHICH IT HAS BEEN APPLIED.

By William Clay, of the Mersey Steel and Iron Works.*

In the Paper which I am now about to submit to your notice, I have endeavoured to treat of this comparatively new process, viz., the manufacture of puddled or wrought steel, with an account of some of the uses to which it has been applied, only in a mechanical and practical point of view, and to avoid entirely any questions as to the chemical change which takes place in the conversion of the crude cast iron into steel; and I have also endeavoured to avoid instituting any comparisons between this process and any others which seek the same result, viz., the manufacture of cheap steel.

* Paper read before the Society of Arts.

It will be well known to many interested in the manufacture of metals, and more especially to any who may have lately had occasion to visit the continent of Europe, that the manufacture of puddled steel has now been practised there for many years, and that the make is rapidly increasing, but, as yet, the uses to which this material has been put are very limited when compared with the vast advantages which would be derived from adopting so strong and durable a material, when produced at a moderate cost.

The process I am about to describe, was patented in the year 1850, by Mr. Ewald Riepe, and it may be asked how it comes to pass that so valuable a patent has been allowed to remain almost entirely unknown in this country, when it was granted so long ago as 1850. One reason is the bad state of health of the patentee, who has seldom been able to devote more than a few days, at any one time, to the subject in this country, without becoming so ill as to be incapacitated from attending to business again for a considerable time. Another reason (as I am informed) is that the patentee, about the date of the patent, came over here and entered into working arrangements with one of the most important firms in this country, viz., the Lowmoor Iron Company, who have, up to this time, made about 1,000 tons of the puddled steel, but who have not, I believe, carried the manufacture of it beyond the puddling process, but have sold the puddled bars to various Sheffield houses for them to carry into the further stages of manufacture, and more especially to Messrs. Naylor, Vickers and Co., of that town, who have used this material very largely for the manufacture of their cast-steel bells, which, I may mention by the way, are also the subject of another patent by the some inventor.

In describing the process of making the puddled steel, I cannot do better than read an extract from the specification of the patentee:—

"Riepe's Patent.—These improvements consist—Firstly, In a peculiar method of working in the puddling furnace. Secondly, In converting pig iron or alloys of pig iron and wrought iron, into steel, with the co-operation of clay in the furnace. Thirdly, In or by the co-operation of atmospheric air.

"Firstly. I employ the puddling furnace in the same way as for making wrought iron. I introduce a charge of about 280 lbs. of pig iron, and raise the temperature to redness. As soon as the metal begins to fuse and trickle down in a fluid state, the damper is to be partially closed, in order to temper the heat. From twelve to sixteen shovelfuls of iron cinder discharged from the rolls or squeezing machine are added, and the whole is to be uniformly melted down. The mass is then to be puddled with the addition of a little black oxide of manganese, common salt, and dry clay, previously ground together. After this mixture has acted for some minutes, the damper is to be fully opened, when about 40 lbs. of pig iron are to be put into the furnace, near the fire-bridge, upon elevated beds of cinder prepared for that purpose. When this pig iron begins to trickle down, and the mass on the bottom of the furnace begins to boil and throw out from the surface the well-known blue jets of flame, the said pig iron is raked into the boiling mass, and the whole is then well mixed together. The mass soon begins to swell up, and the small grains begin to form in it and break through the melted cinder on the surface. As soon as these grains appear the damper is to be three-quarters shut, and the process closely inspected while the mass is being puddled to and fro beneath the covering layer of cinder. During the whole of this process the heat should not be raised above cherry redness, or the welding heat of shear steel. The blue jets of flame gradually disappear, while the formation of grains continues, which grains very soon begin to fuse together, so that the mass becomes waxy, and has the above mentioned cherry redness. If these precautions are not observed, the mass would pass more or less into iron, and no uniform steel product could be obtained. As soon as the mass is finished so far, the fire is stirred to keep the necessary heat for the succeeding operation; the damper is to be entirely shut, and part of the mass is collected into a ball, the remainder always being kept covered with cinder slack. This ball is brought under the hammer, and then worked into bars. The same process is continued until the whole is worked into bars. When I use pig iron made from sparry iron ore, or mixtures of it with other pig iron, I add only about 20 lbs of the former pig iron at the later period of the process, instead of about 40 lbs. When I employ Welsh or pig iron of that description, I throw 10 lbs. of best plastic clay, in a dry granulated state, before the beginning of the process, on the bottom of the furnace. I add at the later period of the process about 40 lbs. of pig iron, as before described, but strew over it clay in the same proportion as just mentioned.

"I do not claim the commencement of the above described process for making steel in the puddling furnace; but what I claim is the regulating the heat in the finishing process, and excluding the atmospheric air from the mass in the manner as described, and also the use or addition of iron to the mass towards the later part of the process."

The remainder of the specification it will not be necessary to allude to.

The balls, instead of being rolled into bars, may be hammered into slabs or blooms, for such uses as forgings, rails, plates, or any hammered or rolled steel which requires to be perfectly solid; but for ordinary use, puddled bars are made, at the Mersey Iron Works, from 2 to 14 in. wide, which are afterwards cut up and piled for various purposes.

In using the puddled bar steel, it has been found very desirable to test each bar before using it, and to closely inspect the quality, and to select such as is best adapted to the purposes required; for instance, for steel rails, or railway points, or switches, which I roll at one operation direct to the regular taper-form desired, under a patent which I have "for rolling iron or other metals of taper form." I select the most crystalline steel for the upper and under surface of the rail or switch, and for the interior that which is of a more fibrous and tougher description. Between the centre and top and bottom of the rail, I place steel of an intermediate grade, which causes the whole pile or mass to weld up easily and work solid.

It is necessary in this, as in any operation in which steel is used, to take the

greatest possible care in the heating and working of the material; but from the first commencement there has been found no difficulty in heating, rolling, or forging this steel into any form or shape, as it has been made into steel plates, bars, angle steel, rivet steel, rails, railway points, and forgings of all kinds, with perfect ease and with success; and ever since the manufacture was commenced at the Mersey Steel and Iron Works, this steel has been used for almost everything that was required to be of a strong and durable nature, or to repair any of those breakages which are of such constant occurrence in every iron work.

It is somewhat worthy of remark that, although this process is so novel, and, apparently, of so delicate a nature, yet, with the specification as my only guide, having never before heard of or seen the operation, it succeeded perfectly in the first trial which was made, and produced so excellent a steel that, after working about 100 tons, it has hardly been surpassed. I have used pig iron of all descriptions, North Welsh, South Welsh, Staffordshire, and Scotch, with the same result, viz., the production of an excellent steel; but I have not found, so far, anything like the great difference that I expected between hot and cold blast iron. Most excellent results have been obtained from both; this is more particularly important, as it shows that the extent to which this manufacture may be carried ueed not be circumscribed by the very limited supply of cold-blast pig iron.

Having thus described the process of manufacture, it will be necessary to show a few of the qualities of the material produced.

The puddled-steel bar when broken shows a clear crystalline and even fracture, and has the usual sonorous musical tone when struck. The crystals appear much finer and more regular than in ordinary blister steel; in fact, to the unpractised eye, the appearance was quite like that of the best cast steel, and it has all these distinguishing features by which steel is known from iron. It hardens to any degree that may be requisite, taking all the colours which develop themselves under the different degrees of heat, and may be made into such articles as ordinary chisels direct from the puddled bar; it will take a very fine polish, and has the same amount of elasticity that steel usually possesses.

In fact, I believe it to be useful in the Arts for all purposes for which steel is required, except, perhaps, for the finer descriptions of tools and cutlery.

One extraordinary feature in regard to this wrought steel is, that it can be produced either of a harsh, hard unyielding character, or of a soft silky fibrous structure, or of any of the grades between these two points, and that a bar when quite cold may be bent up double and perfectly close (with extreme difficulty, certainly, on account of the great stiffness of the material) without the slightest sign of fracture, but, when forced back again, a beautiful long silky fibre is apparent; or if a piece of steel plate be partly cut through with a chisel, and then broken, it appears beautifully fibrous; if made into a tool, for instance, and hardened, it at once assumes the crystalline character peculiar to steel.

In a series of experiments with regard to the improvements and deterioration which result from oft-repeated heating and laminating of bar-iron (undertaken when writing a Paper on "The Forging of Wrought Iron in Large Masses," for a work entitled "The Useful Metals and their Alloys," and detailed at 318 of that work), I found "that taking a quantity of ordinary fibrous puddled iron, and reserving samples marked No. 1, we piled a portion five high, heated and rolled the remainder into bars marked No. 2; again reserving two samples from the centres of these bars, the remainder were piled as before, and so continued until a portion of the iron had undergone twelve workings.

"The following Table shows the tensile strain which each number bore:—

No.		lbs.
1.	Puddled bar	43,904
2.	Re-heated	52,864
3.	"	59,585
4.	"	59,585
5.	"	57,344
6.	"	61,824
7.	"	59,585
8.	"	57,344
9.	"	57,344
10.	"	54,104
11.	"	51,968
12.	"	43,904

"It will thus be seen that the quality of the iron increased up to No. 6 (the slight difference of No. 5 may perhaps be attributed to the sample being slightly defective), and that from No. 6 the descent was in a similar ratio to the previous increase."

In a somewhat similar series of experiments undertaken with this steel, it appears that, after the first piling, when the bars become solid, a deterioration in respect to tensile strength takes place, which is slow and gradual, but in a regularly increasing degree, as will be found by the following Table:—

No.				
No. 1	Puddled steel-bar	bore	96,911	lbs. per square inch.
2	Piled	"	121,408	"
3	"	"	111,608	"
4	"	"	121,408	"
5	"	"	111,608	"
6	"	"	111,608	"
7	"	"	91,136	"
8	"	"	91,136	"
9	"	"	91,136	"
10	"	"	91,136	"

Mem.—The weight increased 20 cwt. at a time.

The steel used for these trials was what chanced to be at hand, and was not particularly remarkable for any extraordiuary degree of strength. Tbe appearance of the fracture of the sample bars, when broken by the hammer in the usual manner, presents to the eye a very slight difference, the colour and size of the crystals being, to all appearance, much the same in No. 2 as in No. 10; but when torn asunder by a machine for the purpose, a very marked difference is observable, the higher numbers having a very fibrous silky fracture; and yet the characteristics of steel are perfectly preserved, for No. 10 hardens, takes the usual colours, in fact, possesses all the distinguishing properties of steel.

I would wish especially to call attention to this steel as a material for large forgings and for ordnance purposes.

It is generally understood in tbis country that cast steel has been, to a certain extent, a failure for such uses, and that it has been found that, unless a considerable amount of hammering or rolling be applied to the cast-steel material subsequently to the founding process, that the strength of such cast-steel material is very inferior to that where it has been consolidated by the action of the hammer or the rolls, and that it is not at all suitable where sudden strains are inevitable.

Mallet, in his valuable work on "The Construction of Artillery," argues that cast steel is not suited for ordnance on account of its deficiency in point of elasticity wben compared with wrought iron or gun metal.

I imagine that this want of elasticity may be partially accounted for in this manner, viz.—Cast steel requires a very high temperature to render it fluid for founding, which necessarily causes a considerable amount of shrinking in the casting wben passing from the fluid to the solid state, and the casting is of that peculiar crystalline structure which is produced under such conditions (weakened to a great extent also by the strain caused by shrinkage), unless the steel casting is afterwards subjected to the hammering or rolling process before mentioned, by which the particles of steel are relieved from their shrinking strain, and are consolidated and allowed to assume a comparative state of repose.

In the manufacture of forgings from puddled steel, the case is very different. We possess, iu the best puddled steel, as great, if not a greater amount of strength, as in cast steel under the most favourable circumstances, and as the particles of wrought or puddled steel are never in a state of fusion from the time of their first formation iu the puddling furnace, the enormous contractile strain incident upon the transition of the steel from the fluid to the solid state, is avoided in the first place, and also the grain of the puddled steel may be so placed in the forging to be made, as the strain which it will be called upon to resist may require, and the different descriptions of steel, whether crystalline or fibrous, may be arranged in the best positious as regards strength and durability. Take, for instance, a large gun forging; the interior may be made of hard crystalline steel, to resist the enormous wear and tear, and the exterior of a softer and more fibrous description, as above described, a result evidently impossible with cast steel, which must necessarily be homogeneous, and be either entirely hard or entirely soft.

It would not surprise me if, with more experience of this new manufacture, it should be found that wrought steel bears the same relative position with regard to cast steel that wrought iron does to cast iron.

There has of late been a considerable controversy respecting an alleged deterioration of wrought iron when being made into large forgings from a supposed crystallisation of the material employed. I have always endeavoured to maintain, and in my work already referred to I have attempted to show, that where this crystallisation took place it was purely the result of carelessness or incompetence.

With wrought steel the danger from this cause is very materially lessened—indeed, rendered almost impossible, for the heat at which it welds is much less than that required to weld iron, as also if the steel be heated too much (and long before any deterioration from crystallisation could set in) the forging, when brought to the hammer, would be so tender that it would fall in pieces, and would in that manner be wasted for the purpose required; there is, therefore, little fear that crystallisation, otherwise bad workmauship, can materially injure this tell-tale production.

Steel forgings have been made at the Mersey Steel and Iron Works into piston rods (some with the piston forged solid, 18 in. diameter, for a Nasmyth hammer), large roll screws, shear pins of all sorts, rolls for rolling iron, hammers, and anvils, and for a variety of other purposes. In making these forgings no difficulty was experienced; rather more time was required on account of the necessity of heating the steel slowly, and also because the hammer did not make the same impression on it that it does upon iron.

The effect of forging upon this steel is to consolidate it, and wheu broken in the usual manner the appearance of the crystals is much fiuer than when it is rolled, as might be expected. Of all the various uses to which this steel may be applied, there are perhaps none so important as its application to marine aud railway purposes. For the former use the material offers directly so considerable a saving in regard to weight, with an equal amount of strength (putting out of the question its durability and other advantages), that its universal adoption can hardly be doubted. A commencement has been made by the Board of Admiralty, who have used considerable quantities of Howell's homogeneous metal in the manufacture of marine steam boilers, as stated in the "Times" newspaper of July 6th, which says:—"In consequence of the successful trials which have been made at Woolwich of Messrs. Shortridge, Howell, and Jessop's homogeneous metal, Government have given directions for the use of that metal in the constructiou of steam boilers, one of which is ordered to be made for thc 17 gun steam-sloop *Malacca*, Captain Arthur Farquhar."

For railway purposes it is nothing new to propose steel for rails, points, and crossings, &c., as the attention of engineers has long been directed to it, both in this country and abroad; but the difficulty has hitherto been the cost of steel for such purposes. Some attempts have been made to harden the face of rails, and to steel the working parts of tyres, but I believe tbe result has not been altogether satisfactory, and the cost considerable; but with wrought steel the tyres, points, or rails, may be made altogether of hard crystalline steel, or an outer surface of hard and an inner portion of fibrous steel, as required; and

at a cost very materially less than that at which steel has hitherto been produced.

With regard to the ultimate resistance to tension of steel as compared with iron, we find by the tables recently published in the reports of experiments on the strength and other properties of metal for cannon made by officers of the United States Ordnance Department, that the strength of various descriptions of English, American, and Russian wrought iron, tested by them, varied from 53,903 lbs. to 62,644 lbs. per square inch.

The ultimate cohesion of tilted cast-steel bars, as published in Table No. 9 of Mallett's work on the construction of artillery, is stated at 142,222 as the highest, with 88,657 as the mean per square inch.

Other estimates of the ultimate cohesion of steel give—

Tempered cast steel at	150,000 lbs.
Cast steel	134,256 „
Shear steel	124,400 „
Blister steel	133,152 „

With wrought steel I have also found considerable variation in regard to tensile strength, more particularly when experimenting, as it is necessary constantly to do in a new manufacture, with various descriptions of pig iron and different charges. But when working regularly I have found no more difficulty in obtaining an uniform result than in the manufacture of iron, and with more experience we may safely expect some improvement even in this particular.

The first bar that was tested broke at 173,817 lbs. per square inch. This extraordinary endurance I have not since equalled, the nearest approach to it being 160,832 lbs. per square inch.

The average tensile strength of the steel, however, may be estimated at about 50 tons per square inch, or 112,000 lbs.

Of four samples tested at the Liverpool Corporation chain-proving machine, on the 8th January, 1858, the first bar, which was made as hard as fire and water could render it, broke at something less than 112,000 lbs., but the exact weight was not ascertained. (This trial bar was from the same steel as No. 3, which, as will be seen, bore the heaviest test in its natural state.) Test bar No. 2 broke at 112,000 lbs., or 50 tons per square inch. No. 3 broke at 125,440, or 56 tons per square inch. No. 4 broke at 98,560 lbs., or 44 tons per square inch.

Mem.—This last sample had a slight flaw, which probably caused the difference.

Table A.—*Tensile strength of Iron and Steel Bars per square inch.*

Description of Iron and Steel.	Tensile strength.	Authority.
Russian Iron..........................	62,644	American Board of Ordnance
English Rolled Iron	56,532	
Lowmoor „	56,103	
American hammered	53,913	
Krupp's Cast Steel, average of 3 samples.	111,707	Minister of War, Berlin
Cast Steel, highest	142,222	Mallet
„ mean	88,657	Ditto
„ „	134,256	
„ tempered	150,000	
Shear Steel	124,000	
Blister „	133,152	
Mersey Steel and Iron Co.—Puddled Steel, highest	173,817	
Ditto, another sample	160,832	
Average of 3 samples tested at the Liverpool Corporation testing machine ...	112,000	

This steel will also be found most useful for chains and ships' cables, and although the few samples which I have had made all broke at the weld, evidently from want of experience on the part of the smith in working this new material, yet the strains borne at the Liverpool Corporation chain-testing machine, even with imperfect welds, are tolerably satisfactory, as will be seen by the following:—

	Tons.	Government proof strain. Tons.	Cwt.
Chain $\frac{9}{16}$ in., close link, broke at	12	3	15
Chain $\frac{6}{16}$ in., stud link, broke at	13	5	10

Table B gives the deflection of hammered and rolled bars of steel and iron with increasing weights.

TABLE B.—TESTS OF STEEL, &c.

BARS 2 INCHES SQUARE, 3 FEET BETWEEN SUPPORTS, WEIGHT IN THE MIDDLE.

	HAMMERED PUDDLED STEEL BAR.				HAMMERED IRON BAR.				ROLLED PUDDLED STEEL BAR.				ROLLED IRON BAR.			
Weight on Centre.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.
T. C.																
3 18	·18	Nil	Nil	Nil	·28	Nil	·14	Nil	·56	Nil	·37	Nil	·84	Nil	·65	Nil
4 18	·37	·18	·14	..	1·03	·74	·79	·65	1·12	·56	·84	·46	1·21	·93	·93	·28
5 18	·75	·37	·51	·37	1·45	·42	1·21	·42	1·78	·65	1·5	·65	2·15	·37	1·87	·93
6 18	1·12	·37	·79	·28	2·03	·57	2·25	·9	2·57	·79	2·25	·75	3·56	1·4	3·28	1·4
7 18	1·68	·56	1·31	·51	3·84	1·81	3·6	1·35	3·37	·79	3·0	·75	5·06	1·5	4·68	1·4
8 18	2·15	·46	1·78	·46	4·93	1·09	4·96	1·51	..	..	..	.	6·75	1·68	6·37	1·75
9 18	2·62	·46	2·25	·46	..	..	..	..	..	..	..	..	..	..	..	..
10 18	3·46	·84	3·09	·84	..	..	..	..	..	..	..	..	..	..	..	..
11 18	4·12	·65	3·75	·65	..	..	..	..	..	..	..	..	..	..	..	..
12 18	4·68	·56	4·31	·56	..	..	..	..	..	..	..	..	..	..	..	..

	TOTAL DEFLECTION.				ADDITIONAL DEFLECTION.				PERMANENT TOTAL SET.				ADDITIONAL PERMANENT SET.			
Weight on Centre.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.
T. C.																
3 18	·18	·28	·56	·84	Nil	Nil	Nil	Nil	Nil	·14	·37	·65	Nil	Nil	Nil	Nil
4 18	·37	1·03	1·12	1·21	·18	·74	·56	·93	·14	·79	·84	·93	..	·65	·46	·28
5 18	·75	1·45	1·78	2·15	·37	·42	·65	·37	·51	1·21	1·5	1·87	·37	·42	·65	·93
6 18	1·12	2·03	2·57	3·56	·37	·57	·79	1·4	·79	2·25	2·25	3·28	·28	·9	·75	1·4
7 18	1·68	3·84	3·37	5·06	·56	1·81	·79	1·5	1·31	3·6	3·0	4·68	·51	1·35	·75	1·4
8 18	2·15	4·93	..	6·75	·46	1·09	..	1·68	1·78	4·96	..	6·37	·46	1·51	..	1·75
9 18	2·62	..	..	..	·46	..	..	..	2·25	..	..	..	·46	..	..	.
10 18	3·46	..	..	..	·84	..	..	..	3·09	..	..	..	·84	..	..	..
11 18	4·12	..	..	..	·65	..	..	..	3·75	..	..	..	·65	..	..	..
12 18	4·68	..	..	..	·56	..	..	..	4·31	..	..	..	·56	..	..	

The samples, as I have since discovered, were of too soft a description, and better results would have been obtained with harder steel, or perhaps the best results might be obtained by a mixture of hard and soft steel, the hard being placed above the neutral axis, the part which is deflected by compression, and the soft, which is deflected by extension, below.

In experimenting upon the strength of this steel, I found the weight requisite

to punch steel and iron plates was relatively as follows. The plates were all ¼-in. thick, and the size of the punch ½-in. (circular).

	Tons.	Cwt.
Ordinary boiler plates, punched with a pressure of......	8	18
Charcoal „ „	8	3
Steel „ „	15	10

In several trials of the tensile strength of steel plates it was found that the strain required to break a square inch of this steel varied from 44 to 55 tons.

It may perhaps be well to mention also that there is no difficulty in working this steel, either hot or cold, in any manner in which the best descriptions of iron are worked, and that no particular knowledge or skill is required on the part of the workmen who use it.

These results show the importance of steel as a material for boilers and shipbuilding purposes, as also for girders and bridges, as the economy in the weight of material required is of the greatest importance for these and for many other similar purposes.

In conclusion, I beg to apologise for the very imperfect Paper that I have had the honour of laying before you; but I would plead in excuse the very limited time that has elapsed since I first commenced the manufacture of this material, and also that, from the extraordinary and novel nature of this steel, I have been often much perplexed and puzzled, and have had to renew experiments again and again before I could fully comprehend the sometimes apparently contradictory facts which presented themselves; and added to this that it was in the first place necessary to unlearn a good deal of what I had always been accustomed to look up to as the foundation of all knowledge of the iron and steel manufacture, a task much more difficult than the acquisition of any new idea, when the mind is not occupied with preconceived notions and old established prejudices.

In the experiments which I have tried I have taken every care to be as accurate as possible, and as the trials have gone on I have had more and more cause to feel confidence in the result obtained, and, had time permitted, I should have been glad to have extended the trials, as the more I investigated the nature of this material the more satisfactory I found it.

I do not for a moment anticipate that steel manufactured by this patent process will supplant the best description of steel; but I feel confident that it must come largely into use for most ordinary purposes, where cast steel, from its great cost, cannot be used.

Indeed, if I might indulge somewhat in prophecy, I would express my belief that, in a few years, the manufacture of this wrought steel will have become as important a branch of our national industry as that of iron now is.

If the few facts which I have, however imperfectly, placed before this Society lead to further inquiry by others more competent, and having more leisure to conduct them to a successful issue, I shall be amply repaid for the time and pains that I have bestowed on the subject.

ROYAL SCOTTISH SOCIETY OF ARTS.

14th December, 1857.

Edward Sang, Esq., F.R.S.E., President, in the Chair.

The following communications were read:—

1. *Improved Electric Lamp.* By Mr. William Hart, philosophical instrument maker, 7, North College-street. Communicated by Dr. Stevenson Macadam.—It was stated that it is now many years since electricity was found capable of yielding a light of dazzling brilliancy, and numerous suggestions were made as to the introduction of the light into lighthouses, but the want of a proper lamp or burner which should admit of the *continuous* exhibition of the luminous arc had hitherto retarded its practical application. Dr. Macadam stated that Mr. Hart had succeeded in constructing an arrangement which admits of the electric light being observed in a manner which has not been surpassed for brilliancy, and has not been equalled for the continuous nature of the light. His lamp was described, and exhibited in action, the principal novelty being an elegant, simple, and ingenious arrangement devised by Mr. Hart, whereby the lamp is made self-adjusting, in respect that the points of the electrodes are always kept at the proper distance from each other. The steadiness and brilliancy of the light called forth general admiration.

2. *Improvement in Graduated Lever Steelyards.* By Henry Cadell, Esq., Grange, Bo'ness. Mr. Cadell stated that while fitting up some steelyards upon the ordinary construction, having a weight travelling upon a graduated lever, he was struck with the fact that the weight indicated, although coming very near, did not correspond exactly with the result which by calculation should have accrued. This, he thought, must arise from the sliding weight not starting from the centre of gravity of the lever, and therefore in part entering into the balancing of the machine; and this seems to have been adverted to by some makers, who remedied the error by balancing the lever without the travelling weight, and commenced the scale at the proper point—the centre; but, as the travelling weight could not get forward to the centre for the eye, its reading commenced at three or four cwt., below which the principal sliding weight had to be removed, and a small one, reading another denomination on the same scale, substituted; and as the great point is to have one correct standard weight moving upon a defined scale, this method did not answer its purpose well. The method devised, which thoroughly corrects the error, and tells any weights within its range accurately, was by making the graduated lever with *two* arms, coming from near the short end, having the bearing centres at their ends, and bent so as to bring the bearings into line with the zero of the scale, and so far asunder as to allow the sliding weight to pass longitudinally between, as shown in the sketch and model exhibited. He also formed the suspender of the sliding weight, so that the scale reads from its centre. By these means the lever may be first balanced alone, and the sliding weight, when put on at zero, should also balance; and upon testing some of the machines thus constructed, he found that they answered *exactly* to the calculated weight. In the model exhibited, which weighs up to 28 lbs., the pounds are marked on the arm of the lever, the intermediate divisions marking ounces; and by a vernier attached to the sliding weight drams are indicated.

11th January, 1858.

The following communications were read:—

On the Forms of Plants in Teneriffe.—By Professor C. Piazzi Smyth, V.P. Illustrated by photographs, electrically illuminated by Mr. Hart.—The author began by treating of the forms of plants in general, and of the Grecian acanthus in particular, in their relation to architectural decoration; and discussed the reasons which have led to the general employment of the latter plant, to the exclusion of forms of native growth. He did not allow that the modern workmen were at all inferior to the ancient; but he found that great difference existed between the upper classes of the two periods in the intense appreciation of originality and nationality which pervaded all the money expenditure of ancient Greece. He also attached some importance to the natural aptitude of the plants of Greece, as one of the hot and dry countries of the world, for architectural decoration; and stated that the same natural characteristics universally prevail in Teneriffe, but have never yet been employed in art. To spread a knowledge, or rather to promote a study, of some of these rich and rare forms, was a leading object in the paper, the reading of which was concluded by an exhibition of photographs of some Teneriffe plants, magnified to 9 feet square, and illuminated by Mr. Hart's new self-adjusting electric light. They were shown with a brilliancy and a vigour which was positively startling; and spoke volumes for the success which has attended Mr. Hart's contrivances for making the electric light practically useful.

Description of a self-acting Air-Door for Mines, to open and shut without any exertion of the passer-through.—By Mr. William Johnston, mineral manager, Carron Co., Falkirk. A working model was exhibited and presented to the Society by Mr. Johnston.—This air-door is intended for the better securing a steady ventilation in mines. It is so constructed that, upon the approach of any person passing along the road, the door opens and shuts perfectly air-tight, without any exertion of the passer-through. This is effected by two small platforms fixed on each side of the door in the centre of the road, and is so constructed that, by means of the levers under the platform, when the weight of the passer-by depresses one of the platforms so as to open the door, it, at the same time, raises another platform on the other side of the door, preparatory to again shutting it when the passer-by passes over this second platform.

Description of a Machine for Transporting and Laying large Gas and Water Mains.—By Mr. William Procter, Engineer, Gas Works, Forfar. A working model was exhibited.—The machine is a compound of mechanical appliances so arranged as to raise from the ground and convey to any place required, also to lower into a trench, gas and water pipes of a large size. It consists of a crane attached to a movable carriage, the tackling of which works over pulleys erected on the carriage, whereby the pipe is either raised from the ground or lowered into the trench with very little trouble. The advantages of this machine over the old method of conveying and laying pipes of a heavy description will be readily perceived when rightly understood. The advantages are—1st. The narrow trench required, having no use for more space than sufficient to drive home the pipe—the pipe hanging in the tackling of crane while being driven home; 2nd. The ease to the men laying, and saving of labour—requiring very few men to work the machine; 3rd. The saving of time, and facility with which the work is done—which is a great consideration, especially in laying pipes along a busy thoroughfare.

LIST OF THE PRINCIPAL INVENTIONS OF THE LATE BRIGADIER-GENERAL SIR SAMUEL BENTHAM, K.S.G., Inspector General of H.M. Naval Works, &c., &c.

We have on various occasions alluded to the extensive list of inventions and improvements introduced by the late General Sir Samuel Bentham, K.S.G., and have made the following selection therefrom, extending from the year 1773 to 1829, and we have classified them, according to the subject, under several heads.

Machinery, Tools, Implements.

	Dates.	Voucher.
An improved chain-pump......................	1773	Ny. Bd. to S. B.
A machine for planing wood and forming mouldings	1781	S. B. to British Ambassador at St. Petersburgh.
Pile-driving machine..........................	1783	P. L.—Describing the machine.
A concealed way-metre acting in a carriage wheel		P. L.—Describing the metre.
Improvement of planing and moulding making machine of 1783	1791	Patent, No. 1838.
A compound work-bench		Do. Do.
A great variety of inventions for the working of wood, metals, stone, and other materials, viz.:—....................	1793	Specification of the Patent.

Machinery, Tools, Implements.

	Date.	Voucher.
Laminated work		No. 1951.
A moveable guide		Do.
Wedges applied to the piece when thin parts of it are cut		Do.
A saw formed of circular segments		Do.
Different cutters for cutting circular grooves, dove-tailed grooves		Do.
Conical do., and fluted do.		Do.
Cutting rollers		Do.
A circular tool to cut mouldings		Do.
A circular plane		Do.
A tilting bench to form waves or other curvatures		Do. Do.
A double cutter, for cuting both sides of a piece at once		Do.
Compound saws, or other cutters		Do.
The slide-rest		Do.
Tubular borers for various purposes, open at the end		Do.
Boring annular grooves		Do.
Spiral stem		Do.
The crown saw		Do.
Machine for making mortices, whether square, oblong, round, &c.		Do.
A rasping bench		Do.
A scoring cross		Do.
A double lathe, or lathe with two handrails		Do.
A presenting bed		Do.
Tubular fire-irons	1793	Patent, No. 1967.
Machine for washing lace	1795	In use at Q. S. P.
Steam dredging apparatus	1800	S. B. Ady.
Floating steam-engine on a navigable river, for dredging purposes		Do. Do.
Steam-engine on wheels	1801	Do. Do.
Engine for making coques	1801	Minutes of Visitation of the Admiralty.
Coque sinking tools		Do. Do.
Treenail making tools and augers		Do. Do.
Rotatory tools, for forming the heads and points of treenails		Do. Do.
Punches for treenails		Do. Do.
Auger- shanks with universal joints		Do. Do.
Apparatus for making nuts for copper bolts, and for forming screw-points		Do. Do.
Wedge-shaped punches for sheathing and bolt-nails		Do. Do.
Saws for converting mast timber by steam power	1812	S. B.—Ny. Bd.

Engineering and Architectural Inventions.

	Date.	Voucher.
The heat of steam from salt beneficially applied to the heating a supply of brine	1781	Salt Works.
Raising a double quantity, by making the upper part of the pipe double, with a piston in each pipe		Do. Do.
Panopticon, or inspection-house	1787	Jeremy Bentham's works.
Fire-proof buildings	1793	Naval papers, official plans, and accounts.
Speaking-tubes	1794	Q. S. P.
The improvement of Portsmouth Harbour	1796	S. B.—Ny. Bd.
Excavating under water in a harbour, so as to procure deep water	1796	S. B.—Ny. Bd.
Floating breakwater, to form a boat-pond	1797	S. B.—Ady.
Waterworks, combined with fire-extinguishing works		Ditto
Double drawbridge	1801	S.B.—To Select Committee of the House of Commons.
New combination of the materials used in the construction of a bridge		Do. Do.
Apparatus below the structure of drawbridge		Do. Do.
Egg-shaped drains	1809	Existing drain in Sheerness dockyd.
Covered docks	1810	S. B.—Ny. Bd.
Timber seasoning houses		Do. Do.
Keeping timber dry instead of under water		Do. Do.
Apparatus for masting vessels worked by steam power machinery		S. B.—Ny. Bd.
Floating breakwater of wood	1811	S. B. — Ny. Bd. — Model in the United Service Institution.
Breakwaters formed of cylindrical masses built afloat		S. B. Ny. Bd.
Breakwaters formed by a semi-subaqueous bridge		Do.
Buoyant masses of cast-iron for forming foundations	1813	Plans for Sheerness dockyard.
Naval basin and canal at Portsmouth harbour	1810	S. B. Ny. Bd.
The construction of a double canal communicating with the sea		Weale's "Quarterly Review."
Foundation masses of brick or stone to be floated to their places	1811	Patent, No. 3429.
Masses pressed into bad ground		200 feet of wall at Sheerness.
A weighted probe to ascertain the weight that ground will bear		Sheerness dockyard.
Temporary exclusion of water to examine underground waterworks		Do. Do.
Ventilation from underground		S. B.—Ny. Bd.
Underground covered roads	1812	Plan for Sheerness.
Watertight cylinder for examining ground under water		Patent, No. 3544

Naval Architecture.

	Date.	Voucher.
Amphibious carriage	1781	S. B. — To British Ambassador at St. Petersburgh, and used at Perme.
Vermicular vessels, formed of separate links, so as to twist about in tortuous rivers		Used at Prince Potemkin's works; and to convey the Empress Catherine II. down the Dnieper.
Diagonal arrangements of the planks of a vessel	1789	"United Serv. Gaz."
Amphibious baggage-waggon		Used at Jassy.
Metal for the shell of a navigable vessel	1794 and 1810	Ex. on the Thames. and at Q. S. P. S. B.—Ny. Bd.
Fixed bulk-heads—diagonal trusses and braces—thick strake pieces in lieu of knees—timber butting against the ends of the vessel—straight decks—metallic tanks for water—metallic canisters for powder — thick glass illuminators — hawse holes and rudders at both the stern and head of a vessel — chain-plates fixed to the thick strake of the vessel—copper pintles and braces, all alike—mechanical steering apparatus —safety lights—step-shaped treenails —short metal screws in lieu of long bolts—form of vessel	1794	Experimental vessels.
Coques, for preventing the sliding of one part on another	1802	S. B.—Ny. Bd.
Screws, pointed bolts, with plates, &c.	1805	S. B.—Ny. Bd.
Bolt-nails, wedge-shaped	1808	S. B.—Ny. Bd.
Metal used in a hollow form in lieu of a solid mass, and the vacuities used as receptacles for provisions, &c.	1810	S. B.—Ny. Bd.; also "Mechanic's Magazine," No. 1313.
Hollow iron pillars to serve as ventilators, &c.	1829	Do. No. 1407.
Coating treenails, &c., with a pigment when inserted		Do.
Winches in lieu of capstan-braces		Do.
Masts of a vessel to act as braces		Do.

Ordnance.

	Date.	Voucher.
Connecting two pieces of ordnance together, so that the recoil of one draws out the other	1787	Naval essays; Naval Papers, No. 7.

	Date.	Voucher.
ORDNANCE.		
Non-recoil of artillery	1788	
Placing ordnance on ship-board, in the intermediate spaces left by the guns.		
Dividing the aim of ordnance	1829	'United Ser. Journal.'
New mode of fixing a small one with a large piece of ordnance	1830	Do.
METALLURGY, &c.		
A new mode of converting iron into steel	1784	S. B. to his Father.
A new variety of Reamur's porcelain ...		Do. Do.
Mixture of metals, so as to increase the hardness and strength of the alloy......	1810	Experimental vessels.
MISCELLANEOUS INVENTIONS.		
A chart of the absolute and comparative population of a part of Russia...........	1783	Made for the Empress Catherine.
The performance of a great variety of operations in *vacuo*, specified as follows:—1. Preservation in point of substance; 2. Distillation; 3. Effectuation of contact; 4. Intromission into tubular or other cavities; 5. Impregnation; 6. Transfiction and Percolation; 7. Mixture; 8. Regulation of heat; 9. Exsiccation		Patent No. 2035.
Improved means of protecting premises by a more efficient mode of placing the guards	1800	
Giving two different employments to the same individual in the dockyards.......	1803 and 1805	Proposed Naval Seminaries. S. B.—Ny. Bd.

REVIEWS.

The Revolver: its Description, Management, and Use, &c. By P. A. Dove, Author of the article, "Gun Making," in the latest edition of the "Encyclopædia Britannica." Edinburgh: Adam and Charles Black. Pp. 57.

THIS little book is devoted chiefly to a description of Adams's excellent patent revolver pistol, which is very accurately illustrated in detail.

It is well worthy of perusal; and, in respect of the topography and illustrations, is well got up.

The sanguinary colour of the binding, which is in keeping with the character of the illustrations on the cover, produces *quite* a startling effect.

Facts for Factories: being Letters on Practical Subjects, suggested by experience in Bombay, E. I. By W. Walker. Bombay, 1857. Pp. 53.

THIS pamphlet contains, in a series of letters, twenty in number, some valuable practical hints upon an endless variety of subjects, more particularly, but not exclusively, of local interest. These letters were originally addressed to the editor of the "Bombay Gazette," and were published in that journal between the 16th August and the 23rd November last.

We have not the slightest notion who Mr. Walker (the author) is, but we have *concluded* that he is a *cute* observer, and all his suggestions have the great merit of being practical and common sense.

The author very justly falls foul of the packers and shippers of machinery, and all kinds of goods and merchandise, from this country to India, for the gross carelessness with which they pack such things. But it is not for the purpose of fault-finding that the author has written and published his letters, but to point out defects, warn those on *this side* of the world, and suggest remedies for the mischiefs complained of. Amongst the articles and things mentioned by the author, as having come under his observation, and as having suffered by carelessness, we may cite those we have most to do with—viz., iron water pipes, platform weighing machines, weigh-bridges, railway semaphores, hand lever-pumps, steam and other machinery, iron castings, axle-boxes, and an endless variety of other things, the annual losses upon which, from breakages and other damages arising from bad packing, which occurs on goods received inward at Bombay alone, is stated by the author to amount to £500,000!! This seems almost incredible; but we are assured by the author it is a fact.

Amongst the many valuable suggestions contained in this series of interesting letters, the author points out the importance of introducing travelling cranes, and other such tackle, for hoisting and removing heavy goods on the wharfs and landing places of Bombay. He suggests that there is an admirable field opened for enterprising ironmongery and hardware dealers to establish themselves in the town; and beyond pointing out the want of an establishment on an extensive scale, he enters into details as to the kind of stock required, the system of doing business, and generally gives such admirable advice that we strongly advise some of our Birmingham and Wolverhampton friends to step forward and respond to the inquiry he makes in his concluding paragraph:—"Who will step in and enjoy this Canaan, overflowing with rupees, selling *good* ironmongery at moderate rates?" Amongst a heap of valuable suggestions, he points out the absurdity of using common or unprotected ironware for the spiral distending core of vulcanized India-rubber tubing, as in India; it very rapidly becomes corroded through, and then cuts and destroys India-rubber tubing. He says all tube-distending wire should be galvanized; and when so prepared, he thinks it preferable even to copper wire.

Complaining of the trash which has recently been sent out to India as "vulcanized India-rubber," he says:—"I have had vulcanized India-rubber packing rings in my possession for seven years past, and they are as good and elastic as when made, which, I think, is a fair proof that it is owing to adulterations, and, probably, insufficiency of sulphur in the manufacture, which affects the durability of articles made from it and used in India."

Of iron blocks made in England and sent out he says, "either iron in this climate undergoes a very considerable alteration in its cohesion of particles, or manufacturers make the strength of hooks considerably below the weight they profess to carry." And he points out other mechanical defects in these articles; but we might go on quoting page after page with profit and advantage to a large number of our readers, and we only regret the citations we have made, being those we find first mentioned, are not even fair specimens of the admirable manner in which the author has dealt with a number of very important subjects of great interest to engineers, manufacturers, and shippers of goods, as also to the clever mechanic seeking employment, and who does not object to the climate of India; and it is much to be regretted that we are unable to state where this book is to be obtained in London, but any subscriber to THE ARTIZAN, who may feel interested and desire to read the pamphlet, may peruse it at the Publishing Office.

Laxton's Builder's Price Book for 1858. Thirty-sixth edition.

THIS annual thoroughly sustains the high reputation which it has acquired in the course of the thirty-five previous editions. Considerable additions have been made to the previously extensive stock of useful information it contained, and in its present form will be found of great assistance to mechanical engineers, machinists, founders, and others.

The Geologist: a Popular Monthly Magazine of Geology. London: Simpkin and Co. Kenilworth: Walter T. Parsons. Vol. 1, No. 1. January, 1858.

WE have received the first number of the above monthly, and wish it every success. Such a work has long been wanted, and if conducted with talent and a liberal spirit, we have no doubt that it will meet with support. The first number is creditably got up, though wanting in quantity of matter. We are glad, however, to see that they have an excellent foreign correspondent in Dr. T. L. Phipson, of Paris, contributions from whom we hope to find in the pages of the future numbers of "The Geologist."

A Centuary of Suggestions addressed to the Sleepy. By one of Themselves. Mountcastle's Library, King Street, Covent Garden. Pp. 51.

THIS is a series of one hundred suggestions, many of them excellent, and many more with which we cannot agree, and some few that we do not rightly understand the value of; but the book is well worthy of perusal, and should be read by every one who can afford to spend sixpence for its purchase, for every one who reads it may find in it something to afford him ample profit and pleasure in return for the investment.

Iron Ship Building, with Practical Illustrations. By John Grantham, C.E. London: John Weale. 1858.

WE are reluctantly compelled to postpone until next month the publication of our second notice of this excellent work, in consequence of our inability to find space for it, and for several other notices of books, &c.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

BURN (R. S.)—Mechanics and Mechanism: being Elementary Essays and Examples for the use of Schools and Students. Edited by Robert Scott Burn. 3rd edit., 8vo, pp. 126, cloth, 2s. (Ward and L.)

GRAHAM (T.)—Elements of Chemistry; including the Applications of the Science in the Arts. By Thomas Graham and Henry Watts. 2nd edit., 2 vols. Vol. 2, 8vo, pp. 800, cloth, 2 s. (Library of Illustrated Scientific Works.) (Baillière.)

GRIFFIN (J. J.)—The Radical Theory in Chemistry. By John Joseph Griffin. Post 8vo, pp. 570, cloth, 12s. 6d. (Griffin.)

HALKETT (P. Q.)—Guideway Steam Agriculture. By. P. Q. Halkett. With a Report by — Braithwaite, Esq., 8vo, pp. 15, sewed, 6d. (Ridgway.)

HUMBER (W.)—A Practical Treatise on Cast and Wrought Iron Bridges and Girders, as applied to Railway Structures and to Buildings generally: with numerous Examples, drawn to a large scale, selected from the Public Works of the most eminent Engineers. By William Humber. Folio, half-bound, 70s. (Spon.)

JUKES (J. B.)—The Student's Manual of Geology. By J. Beete Jukes. Post 8vo. (Edinburgh), pp. 616, cloth, 8s. 6d. (Longman.)

KIPPING (R.)—Elementary Treatise on Sails and Sailmaking, with Draughting, and the Centre and Effort of the Sails; also Weights of Ropes, Masting, Rigging, and Sails of Steam Vessels: with Dimensions for Jibs, Mainsails, &c., relative to every class of vessels. With Appendix, &c. By Robert Kipping. 12mo, pp. 184, cloth, 2s. 6d. (C. Wilson.)

LAXTON'S Builders' Price Book for 1858, containing upwards of 8,000 Prices, carefully corrected from the present Prices of Materials and Labour, &c. By William Laxton. 36th edit., 12mo, pp. 300, cloth, 4s. (Knott.)

MAIN (T. J.) and BROWN (T.)—The Indicator and Dynamometer, with their Practical Applications to the Steam Engine. By Thomas J. Main and Thomas Brown. 3rd. edit., 8vo, pp. 64, cloth, 4s. 6d. (Longman.)

*MASON (G. C.)—The Application of Art to Manufactures. By George C. Mason. 12mo. (New York), with 150 illustrations, pp. 344, cloth, London, 10s. 6d.

MONRO (B. J.)—Tables for Calculating Measurement; Freights, Inwards and Outwards, at Rates ranging from 2s. 6d. to £20 per ton, of 40 and 50 cubic feet, and embracing Measurements from 1 inch to 6,000 cubic feet. By B. James Monro. 12mo, pp. 90, cloth, 10s. (Richardsons.)

PHILLIPS (W. H.)—The Gas Ram a Hundred Times more powerful than the Hydraulic Ram for launching the Leviathan. 8vo, pp. 12, sewed, 3d. (Partridge.)

*PIERCE (E. L.)—A Treatise on American Railroad Law. By Edward L. Pierce. 8vo. (New York), pp. 613, boards, London, 25s.

*REPORT OF THE COMMISSIONERS OF PATENTS for the year 1856. Vols. 1, 2, 3, —Arts and Manufactures, pp. 640, 518, 592; Vol. 3, containing the plates and Index. Vol. 4—Agriculture, pp. 553, with 50 plates. 8vo, (Washington), cloth, London, together 24s.

*REPORTS OF EXPLORATIONS AND SURVEYS, to ascertain the most practicable and economical route for a Railroad from the Mississippi River to the Pacific Ocean, made under the direction of the Secretary at War in 1853-54, according to Acts of Conquest of March 3, 1853; May 31, 1854; and August 5, 1854. Vol. 3, pp. 164, with three geological maps. Vol. 4, pp. 288. 4to. (Washington), cloth, London, each 42s.

* American Works.

EAST INDIAN RAILWAYS.

Construction of Bridges and Viaducts.

An interesting test, in reference to the strength of iron railway bridges for Indian railways, took place on Thursday, January 21st, at the works of Messrs. Westwood, Baillie, Campbell, and Co., London Yard, Isle of Dogs.

Colonel Kennedy, the chief engineer of the Bombay and Baroda Railway Company, has, in a series of very able Papers, pointed out to the consideration of his directors, and those who are interested in the cheap and rapid construction of railways in India, the importance of completing a system under which all the bridges and viaducts should be carried out on a principle which will admit of the adaptation of the portions of any one of these structures to the repair or reformation of any other, or all of them. In fact, Colonel Kennedy's system is that the bridges and spans of all his similar works shall be identical in their parts—a system which (he states), if it had been applied to the construction of such works in this country, and to the building of our locomotives, would have effected a saving of some hundreds of thousands per annum in the repairs of our permanent ways and rolling stock.

The iron bridge tested is of 60 ft. span; it is elegant in structure, and its economy will be understood from the fact that the whole weight of it is within 21 tons. The entire load placed upon the bridge was $108\frac{1}{2}$ tons. With $15\frac{1}{2}$ tons upon the centre the deflection was 3-16ths of an inch; with 31 tons, 5-16ths; with $46\frac{1}{2}$ tons, 7-16ths; and with the gross weight mentioned, $11\frac{1}{2}$-16ths.

The test had reference to the Nerbudda Bridge on the Bombay and Baroda line, and it was one of a series of tests to which the parts of these structures are put as often as any large number of girders are prepared at the establishment. The mode in which the strength of these materials is tested is to select indiscriminately from the constituent portions of about 40 girders the portions necessary to make up one span, so that it amounts to a double proof, namely, the strength of the principal girders and the general accuracy of the workmanship of the whole of the materials. The result of the test was precisely analogous with the results which we understand had preceded it. The load placed upon the bridge was double the weight that can possibly be placed upon it in the working of ordinary railway traffic. After taking the extreme deflection with the full load the waggons were removed, and the bridge came back to its original position, without any appreciable permanent set; a fact highly creditable to the manufacturers, inasmuch as the amount of permanent set usual in structures of this character may be fairly considered a measure of the perfection or imperfection of workmanship. We may observe, that the "camber" before and after the experiment was precisely $2\frac{1}{4}$ inches.

The party having satisfied themselves that there was not any permanent set in the structure, Colonel Kennedy ordered the workmen to withdraw the pin on the lower tension bar nearest to the pier, where the structure sustains the greatest strain, and upon a close examination it was found that the pin was not in the slightest degree strained. A great deal in reference to the progress of the railway system in India will probably depend upon the adoption of an economical system of constructing bridges and viaducts Tunnelling and masonry to a very great extent regulate the periods in which railways, especially in India, can be carried out. The rivers of India offer the chief impediment to rapid construction. The principle adopted by the Bombay and Baroda Company is to manufacture both the superstructure and the piers of the bridges in the forges of England; and by the adoption of Warren's principle for bridges, and Mitchell's screw piles for piers, the least possible work has to be effected for placing them in their position, and masonry is to the utmost possible extent dispensed with. If our memory serves us correctly, Colonel Kennedy stated at the last meeting of this company that he would be able to complete the line at a cost little over £6,000 per mile, including bridges and viaducts.—*Evening Herald*.

CORRESPONDENCE.

ON THE COMPARATIVE CAPABILITIES OF STEAM SHIPS AS DEPENDING ON THEIR MAGNITUDE.

To the Editor of The Artizan.

Sir,—Various discussions on "Steam-ship Capability" having been prominently brought forward in The Artizan, I have to request the favour of your publishing my present communication, which was in part obligingly published in the "Society of Arts Journal," of 25th ult., and I now wish to avail myself of The Artizan, as, from communications which I have lately received, it appears that my Paper on the purely abstract question (which its title enunciates), has given rise to inferences of a purport that I do not recognise. I therefore beg to observe that I do not raise the question whether steam-ships of unprecedented size, as measured by their *load displacement* (for tonnage, whether by builder's measurement or register measurement, is no measurement at all as to the effective sizes or weight-carrying capabilities of ships) can or cannot have such conditions of service assigned to them as shall commercially—that is, profitably—defy the competition of smaller vessels. As an engineer, I do not take up the *mercantile* considerations of the case; but admitting, as I do, the inherent superior capability of large ships as compared with smaller vessels of the same type of form, in a mechanical point of view, irrespectively of mercantile demand, and mercantile and nautical management, my object has been to establish a system of calculation, whereby we may determine theoretically to what extent, and on what pecuniary conditions, ships of unprecedented magnitude may undertake the obligation of steaming at a higher rate of speed, combined with a greater length of passage, without re-coaling, than is undertaken by smaller vessels; the test of competition being the prime cost rate of expenses incurred per ton weight of cargo conveyed, assuming the vessels to be always fully loaded. Such is the investigation intended to be agitated by the following Paper, published in the "Society of Arts Journal," as above referred to:—

"Experience of the past four years, especially in connection with the Steam Transport Service of the Crimean war—events now in progress as respects our steam communication with China and India for military purposes—the present aspect of the probable future, opening up as it does a totally new era and order of things as respects mercantile intercommunication between England and the far distant regions of India, Australia, China, California, and Japan, involving the circumnavigation of the globe by the agency of steam—are circumstances which at the present time give peculiar significance to an inquiry which of late I have been instrumental in agitating—viz., an inquiry into the capabilities of steam-ships of extraordinary magnitude as compared with the capabilities of vessels of ordinary size. Under the influence of these convictions, as to the material importance of this subject, vitally connected as it is with the future advancement of arts, manufactures, and commerce, I beg to be permitted to avail myself of the facilities afforded by the Press to promulgate certain inquiries and investigations on the subject referred to, and which, though previously brought forward elsewhere,* have never been subjected to the ordeal of public discussion, such as the importance of the inquiry undoubtedly demands.

"Having thus briefly explained the purpose of my communication, I proceed, with your permission, to bring before the notice of your numerous readers the views which I entertain in demonstration.

"1st. As to the superior capabilities of large ships, as compared with smaller vessels, in a purely mechanical point of view, for the performance of any specified length of voyage, without re-coaling, at any given rate of speed.

"2nd. As to the mercantile limitations at which the admitted mechanical advantage which results from increased size of ship becomes neutralised, if, on the strength of increased size alone, we undertake mercantile obligations involving the stipulated performance of an increased rate of speed, combined with an increased distance without re-coaling, such, for example, as making a long passage direct without touching at intermediate coaling stations, which may be accessible to, and made available by, smaller vessels.

"The elemental data on which the following tabular statements have been calculated are as follow, viz.:—That the weight of the hull and equipment (exclusive of the engines and coals), when ready for sea, will appropriate 40 per cent. of the mean displacement; that the weight of the engines, boilers, &c., in complete working order, will be 5 cwt. per indicated H.P.; that the consumption of coals will be at the rate of $4\frac{1}{2}$ lbs. per indicated H.P. per hour; that the type and condition of vessel, and the performance of the engines, will be such as when deduced from the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C$, will give a coefficient or index number (C) equal to the number 215·5, which is believed to be a high average estimate of the scale of duty performed by steam-ships at sea.

"With these elemental data, it is purposed to show, in tabular form, the respective capabilities of a series of vessels of the following progressive sizes, as measured by their mean sea-displacement, viz., 5,000 tons mean displacement, 10,000 tons, and 20,000 tons mean displacement, the mutual relations of displacement, power, and speed being calculated by the formula above stated.

"Table No. 1, showing the superior capability of large ships, as indicated by a progressively increasing rate of speed corresponding to a progressively increasing size of ship; the proportion of displacement to power being assumed, in all cases, constant, namely, 2 tons weight of displacement to 1 indicated H.P. of 33,000 lb., raised 1 ft. per minute:—

* Appendix to Atherton's "Steam Ship Capability" (2nd Edition).

Displacement. Tons.	Indicated H.P.	Speed. Knots.
5,000	2,500	12·27
10,000	5,000	13·25
20,000	10,000	14·31

Hence it appears that the same proportion of power to displacement which drives ships of 5,000 tons displacement 12 knots an hour, will drive a ship of 10,000 tons, on the same type of build, at 13 knots, and a ship of 20,000 tons at 14 knots per hour.

"Table No. 2, showing the superior capability of large ships as indicated by the progressively reduced ratio of power to displacement, whereby a constant speed is given to vessels of progressively increasing size; the calculation being made for the constant speed of 15 nautical miles an hour:—

Displacement. Tons.	Speed. Knots.	Indicated H.P.	Ratio of Displacement to Indicated H.P.
5,000	15	4,569	100 to 91
10,000	15	7,252	100 to 72
20,000	15	11,513	100 to 57

"Hence it appears that, to attain the speed of 15 knots an hour, the ship of 5,000 tons displacement requires 91 indicated H.P. for each 100 tons of displacement; but the ship of 10,000 tons displacement, on the same type of build, requires 72 indicated H.P. for each 100 tons displacement; and the ship of 20,000 tons, on the same type of build, will require only 57 indicated H.P. for each 100 tons of displacement.

"Table No. 3, showing the superior capability of large ships as indicated by the progressively increasing distance capable of being run, without re-coaling, at a given rate of speed (say 15 knots an hour), and with a given per centage of the displacement appropriated to cargo (say 10 per cent.)

Mid-passage Displacement.	Speed.	Indicated H.P.	Cargo (10 per cent. of Displacement).	Coal.	Distance (without re-coaling).
Tons.	Knots.		Tons.	Tons.	Naut. Miles.
5,000	15	4,569	500	2,716	4,440
10,000	15	7,252	1,000	6,374	6,555
20,000	15	11,513	2,000	14,244	9,240

"Hence it appears that, at the speed of 15 knots an hour, and with 10 per cent. of the displacement appropriated to cargo, the ship of 5,000 tons displacement will steam a distance of only 4,440 miles without re-coaling; but the ship of 10,000 tons will, under the same conditions, steam 6,555 miles without re-coaling; and the ship of 20,000 tons will, under the same conditions, steam 9,240 miles without re-coaling, at the speed of 15 knots per hour.

"Table No. 4, showing the superior capability of large ships as indicated by the reduced consumption of fuel per ton of cargo at which goods will be conveyed a given distance, without re-coaling, at a given speed; supposing, for example, that the distance, without re-coaling, is to be 3,250 nautical miles, and the speed 10 nautical miles an hour:—

Mid-passage Displacement.	Speed (per hour).	Indicated H.P.	Distance.	Coal.	Cargo.	Tons of Coal per Ton of Cargo.	Deep-draught Displacement.
Tons.	Knots.		Naut. Miles.	Tons.	Tons.		Tons.
5,000	10	1,354	3,250	884	2,219	·40	5,442
10,000	10	2,149	3,250	1,403	4,762	·29	10,701
20,000	10	3,411	3,250	2,227	10,034	·22	21,113

"Hence it appears that, in the case of a 3,250 miles direct passage at 10 knots an hour, by increasing the size of the ship from 5,442 tons to 21,113 tons of deep-draught displacement, the consumption of coal per ton of cargo conveyed is reduced from $\frac{40}{100}$ down to $\frac{22}{100}$, being a reduction of nearly 50 per cent. in favour of the larger ship.

"The foregoing tables having thus illustrated the superior capabilities of large ships as compared with smaller vessels for the performance of any special service under the same specific conditions of speed and distance without re-coaling, the following table (No. 5) is intended to show how soon the admitted advantages which result from increased size become neutralized, if, on the strength of increased size alone, we undertake obligations which involve, on the part of a large ship, an increased rate of speed combined with an increased distance, without re-coaling; to demonstrate which, we will assume that in the prosecution of a steam-ship project on a line of communication extending a distance of 12,500 nautical miles (such, for example, as the line between England and Calcutta), it is intended to employ shipping to the aggregate extent of about 20,000 tons, to be propelled by steam-power in the proportion of 2 tons of displacement to 1 indicated H.P. The problem now is to determine whether, as respects speed and the consumption of coal per ton weight of cargo conveyed, the proposed service will be most advantageously performed by

"SCHEME No. 1, VIZ.:

"One vessel of 20,000 tons, mean or mid passage displacement and 10,000 indicated H.P., making the passage of 12,500 nautical miles *direct*, at the speed of 14·31 nautical miles an hour; or by

"SCHEME No. 2, VIZ.:

"Two vessels, each of 10,000 tons mean or mid passage displacement and and 5,000 indicated H.P., making the passage in two stages of 6,250 nautical miles, at the speed of 13·25 nautical miles an hour; or by

"SCHEME No. 3, VIZ.:

"Four vessels, each of 5,000 tons mean or mid passage displacement and 2,500 indicated H.P., making the passage in four stages of 3,250 nautical miles, at the speed of 12·27 nautical miles an hour.

"It will be found, by calculations based on the data before referred to, that the mutual relations of displacement, power, speed, length of passage, cargo, and coals, which result respectively from the above mentioned three schemes of shipping, will be as represented by the following Table, No. 5:—

Scheme.	Mean or Mid-passage Displacement.	Indicated H.P.	Speed per hour.	Distance, 12,500 Nautical Miles.	Steaming Time.	Consumption of Coal on the entire passage.	Cargo.	Coal per Ton of Cargo.	Deep Displacement.
	Tons.		N.M.		D.H.	Tons.	Tons.	Tons.	Tons.
1	20,000	10,000	14·31	1 stage of 12500	36·10	17,550	725	24	28,775
2	10,000	5,000	13·25	2 stages of 6250 = 12500	39·8	9,478	2,381	4	12,369
3	5,000	2,500	12·27	4 stages of 3250 = 13000	44·3	5,316	1,711	3	5,664

"From the above Table we observe the following results, viz.:—

"The steaming speeds by the above proposed three schemes respectively will be at the rate of about 14, 13, and 12 nautical miles per hour; the steaming time at sea on the passage of 12,500 miles will be about 36, 39, and 44 days, by the three schemes respectively, and allowing four days for re-coaling the 10,000 tons ship (Scheme No. 2) at the one intermediate station, and two days for re-coaling the 5,000 tons ship (Scheme No. 3) at each of the three intermediate stations, being altogether six days, then the whole time of passage between England and Calcutta by the three schemes respectively would be 36 days, 43 days, and 50 days, being 14 days shorter time of passage in favour of the one ship (Scheme No. 1) as compared with the four ships (Scheme No. 3): but the mercantile sacrifice which attends this saving of 14 days, by Scheme No. 1, as compared with Scheme No. 3, is, that by Scheme No. 1, 17,550 tons of coal are consumed in the conveyance of only 725 tons of cargo, being at the rate of 24 tons of coal per ton of cargo, while *each* of the four ships of Scheme No. 3 consumes 5,316 tons of coal in the conveyance of 1,711 tons of cargo, being at the rate of 3 tons of coal per ton of cargo. Thus, notwithstanding the superior capabilities of large ships as compared with smaller vessels for performing any special service on equal conditions, in regard to speed and distance without re-coaling (as shown by Tables 1, 2, 3, and 4), we see, in the case now before us (as shown by Table No. 5), assuming each ship to make the same number of passages per annum (for the larger ships, though a shorter time at sea, will be detained the longer in port), that the four ship Scheme, No. 3, as compared with the one ship Scheme, No. 1, is, under the different conditions as to speed and coaling stations above stated, capable of transporting between England and Calcutta, nearly ten times the aggregate weight of cargo per annum with 1-8th of the consumption of coal per ton of cargo conveyed, but with an admitted sacrifice of 14 days on the time of passage.

"If, however, the consumption of fuel on board of ship be reduced from $4\frac{1}{2}$ lbs. per indicated H.P. per hour, on which the foregoing calculations have been based, down to 3 lbs. per indicated H.P. per hour, which is theoretically possible, and, therefore, it is hoped, may be achieved, then, on the same principle of calculation and under the above stated conditions as to loss of time by Scheme No. 3, it would still be found that the four ship Scheme, No. 3, as compared with the one ship Scheme, No. 1, would transport about double the weight of cargo per annum between England and Calcutta with about one-half of the consumption of fuel per ton of cargo conveyed; but, as before stated, with an admitted sacrifice of 14 days on the time of passage.

"The consumption of fuel per ton of cargo conveyed is, as one item of expense, perhaps the best criterion of the relative merits of different schemes of steam navigation as respects mercantile economy; and, on inspecting Table No. 5, with reference to this point, it will be observed that the second and third schemes are very nearly on a par with each other; that is, under the assumed working arrangements of these schemes as above set forth, a vessel of 5,664 tons deep-draught displacement, fitted for steaming at 12 knots per hour, and re-coaling at intervals of 3,250 miles, will convey cargo somewhat more economically than a vessel of 12,369 tons deep-draught displacement, fitted for steaming at 13 knots per hour, and re-coaling at intervals of 6,250 nautical miles; and as compared with a vessel of 28,775 tons deep-draught displacement, fitted for steaming at 14 knots per hour, and making the passage of 12,500 miles direct, without re-coaling at any intermediate station, the difference in point of freight economy, as indicated by the economy of coal per ton of cargo conveyed, is so greatly in favour of the smaller vessel, time excepted, that a vessel working under such conditions, viz., 14-knot speed combined with a 12,500 mile distance, without re-coaling, can only be regarded as a packet-ship for mails and passengers not profitably available for mercantile cargo.

"If, however, the ship for Scheme No. 1, be constructed for a deep-draught displacement of 25,000 tons, and be fitted for the reduced speed of 12 knots per hour, the direct passage of 12,500 miles would then occupy 44 days, the consumption of fuel at 3 lbs. per indicated H.P. per hour would be 12,000 tons,

and the displacement available for cargo would be 4,000 tons weight, being at the rate of 3 tons of coal per ton of cargo conveyed, or about the same expenditure of coal per ton of cargo as that incurred by each of the 5,664 tons ships (Scheme No. 3), steaming at the same speed, viz., 12 knots per hour, but re-coaling at intervals of 3,250 nautical miles, and taking, including stoppages (6 days) for re-coaling, 50 days for the passage; being an admitted superiority of 6 days in favour of the direct passage of the ship of 26,000 tons. The question is, whether this result, viz., the saving of 6 days by the large ship, will adequately compensate for the extraordinary requirements of its realisation.

"In all the foregoing statements, the mutual relation of displacement, power, and speed, have been calculated without reference to the influence of wind and current, which, indeed, may be regarded as obstructing the regular performance of a high speed service; for, a favourable wind such as might help a vessel steaming at 12 knots an hour (as in Scheme No. 3), may afford no aid, or even oppose a vessel steaming at 14 knots an hour (as in Scheme No. 1); and an adverse wind will obstruct a vessel steaming at a high speed in a greater ratio than it would obstruct the low speed ship.

"Sailing clippers scarcely average 7½ knots per hour; an average speed of 10 knots may be expected from the joint action of sail and auxiliary steam-power; but an average speed of 15 knots outruns even a favourable wind, and can only be depended upon from steam alone.

"The foregoing remarks presume on there being no limitation to the draught of water whereby the ship of extraordinary magnitude may be prevented from having that type of form, as respects the proportions of length and breadth to depth, which is found to be most conducive to the realisation of a high scale or coefficient of dynamic duty, and which may be adopted in the construction of the smaller vessels, its rivals. This is one obstacle tending to limit the magnitude of ships; and another obstacle of a somewhat analogous character consists in this, viz., that the cost of the construction of ships, and in some respects the working charges on shipping, are regulated by their nominal tonnage, either builder's tonnage or register tonnage; and it admits of demonstration, that neither the builder's tonnage nor the register tonnage is any definite or proportional measure of the respective weight-carrying capabilities of ships of different proportions of build, but it is found that the shallower a ship is in proportion to her beam, the smaller will be her weight-carrying capability in proportion to her builder's or register tonnage. For example: a ship of 1,000 tons builder's measure, of which the load-draught of water is one-half of the beam, may be able to carry 800 tons weight, but another ship of 1,000 tons, having the load-draught of water only one-third of the beam, would probably carry only 450 tons; and yet the cost of construction of both these ships may be nearly the same, though one is capable of carrying nearly double the weight of the other.* Hence, therefore, the probability of a ship of extraordinary length and breadth, but comparatively shallow depth, being constructively an expensive ship in proportion to her capability for carrying tons weight of cargo, even though always loaded down to her deep-draught line; but it is to be observed that such vessels, though unfavourable for heavy cargo, afford great accommodation for the conveyance of passengers.

"Such are a few deductions, from mechanical principles, which, irrespectively of commercial considerations as to the loss which may result from monster ships being laid up for repairs, or inadequately loaded on the one hand, or the market of their destination being suddenly glutted on the other, manifestly constitute most serious matter for reflection in connection with monster ships; times and circumstances may demand their use, but times and circumstances also impose limits, both mechanical and mercantile, to the advantageous construction and employment of monster ships, which, if not duly considered, are likely to result in a monster mistake."

The foregoing Paper refers almost exclusively to the mutual relations of displacement, speed, and coals; it does not fully embrace the consideration of cost expenses incurred in steam-ship transport service; and I now beg to extend my remarks thereon with reference to the conditions of service under which steamers of different sizes will be on a par with each other, as respects the prime cost expenses incurred per ton weight of cargo conveyed, observing, that calculations of this description can only be based on assumed data applicable to the circumstances of the service on which the vessels are to be employed; but, for illustration of the principle of such calculations, I refer to the examples given in the tabular statement at pages 84 and 87 of the above-named Essay ("Steam-ship Capability," 2nd Edition), with the assumed data on which the calculations are founded, presenting the following results:

1st. That on a direct passage of 3,250 nautical miles a ship of 2,788 tons load displacement, fitted for steaming at 10 knots per hour, taking 13½ days on the passage, may be expected to compete (very nearly), as respects cost of freight per ton weight of cargo conveyed, with a ship of 5,551 tons load displacement, fitted for steaming at 11 knots per hour, taking 12¼ days; or with a ship of 11,229 tons load displacement, fitted for steaming at 13 knots per hour, taking 10½ days; or with a ship of 22,264 tons load displacement, fitted for steaming at 14 knots per hour, taking 9⅝ days.

2nd. That on a passage of 6,500 nautical miles to be steamed direct, without re-coaling at any intermediate station, a ship of 3,077 tons load displacement, steaming at 10 knots per hour, taking 27 days, may be expected to compete (very nearly) with a ship of 6,103 tons load displacement, steaming 11 knots, per hour, taking 24⅝ days; or with a ship of 12,458 tons steaming at 13 knots, taking 20⅝ days; or with a ship of 14,528 tons load displacement, steaming at 14 knots per hour, taking 19⅓ days.

3rd. That on a passage of 12,500 nautical miles to be steamed direct, without re-coaling at any intermediate station, a ship of 3,209 tons load displacement, fitted for steaming at 8 knots per hour, taking 65 days, may be expected to compete (very nearly) with a ship of 6,418 tons, fitted for steaming at 9 knots, taking 58 days; or with a ship of 12,791, tons fitted for steaming at 10 knots, taking 52 days; or with a ship of 26,389 tons load displacement, fitted for steaming at 12 knots per hour, taking 43½ days.

4th. That on a passage of 12,500 nautical miles, a ship of 5,655 tons load displacement, fitted for steaming at 12 knots per hour, and re-coaling at three intermediate stations, taking 51 days on the whole voyage, including 6 days re-coaling, may be expected to compete with a ship of 12,094 tons, fitted for steaming at 12 knots, and re-coaling at one intermediate station, taking 49 days, including 4 days re-coaling, or with a ship of 26,389 tons load displacement, fitted for steaming at 12 knots per hour, and performing the whole distance direct without re-coaling, taking 43½ days on the voyage of 12,500 nautical miles.

Such appears to be the conditions of service on which ships of various sizes as determined by their respective load displacements, and all of the same type or scale of dynamic merit as determined by the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C = 215{\cdot}5$, can compete with each other in the matter of goods conveyance per ton weight of cargo conveyed, observing, however, that in the foregoing calculations, mercantile and nautical considerations, as differently affecting the various sizes of ships, are not taken into the account; the vessels are assumed to be in all cases fully loaded, and to be at sea the same number of days per annum.

Hence, it appears that the superior capability of large ships, as compared with smaller vessels, is, in a theoretically-mechanical point of view, unquestionable, though not so to such an extent as has been generally presumed to be the case; and, in fact, this admitted mechanical superiority appears to be so limited as respects the combination of an increased rate of speed with greater distance without re-coaling, that mercantile considerations with reference to the requirements and convenience of trade, and the special conditions or requirements of the service to be performed, especially in regard to speed, constitute essentially the data on which the size and power of steam-ships requires being regulated. The Dynamic aspect of any steam-ship project, so far as dependent on construction, admits of being approximately calculated. If, however, the requirements of trade be not judged of by existing statistical data, but made the subject of prophetical anticipation, the adaptation of vessels to meet such anticipations then becomes a matter of speculation, the success or failure of which cannot be predicated by any system of mercantile steam transport arithmetic. I am, Sir, your very obedient servant,

Royal Dockyard, Woolwich, Chas. Atherton.
18th January, 1858.

* See The Artizan, August, 1857: "Suggestions for Statistical Inquiry into the Extent to which Mercantile Steam Transport Economy is Affected by the Constructive Type of Shipping, as Respects the proportions of Length, Breadth, and Depth," by Charles Atherton.

ON THE COEFFICIENT OF STRENGTH FOR WROUGHT-IRON BEAMS.

To the Editor of The Artizan.

Sir,—A question of very considerable importance has been raised by Mr. Hughes's papers on the strength of beams and girders—viz., the validity of the conclusions arrived at by Mr. Fairbairn, from his experiments on wrought-iron beams. In replying to a communication of mine, Mr. Hughes reiterates that "it is impossible, from the experiments (of Mr. F.), to fix on a proper coefficient for the strength of wrought-iron beams." This is a matter of no little moment, for, as this material is daily more and more employed, it is of increasing importance that we should know the principles which regulate its form, and the rules which determine its strength. Mr. H. tries to invalidate the only experimental knowledge we possess—would destroy our reliance on a beautiful series of experiments which have led to the most important practical results—and yet, can ask our confidence for no other.

The data in question are as follow:—

Table I.—*Breaking Weight of Box-Beams.*

No. of Experiment.	Breaking weight in tons.	Area of section.	Ratio of bottom to top flange.	Breaking weight reduced to unity of length, depth, and area.	Gave way by
(1) 15	1·74	4·04	1 : 0·53	·78	Compression
(2) 17	8·03	8·00	1 : 0·60	1·60	,,
(3) 25A	3·20	2·90	1 : 0·61	1·51	,,
(4) 14	1·71	3·20	1 : 1·01	·96*	,,
(5) 25	5·05	2·90	1 : 1·62	2·39	,,
(6) 15A	3·24	4·04	1 : 1·88	1·47	Extension
(7) 14A	3·73	5·32	1 : 3·36	1·27	,,

Now, on examining the above table, the first point for remark is the consistency of the last column. The beams being made with a varied distribution of material, and the area of the section of the top flange being successively augmented at the expense of that of the bottom flange, we notice that until the bottom flange bore a ratio of 1 : 1·62 to the top flange, the beams gave way by compression; but that when that proportion was further increased, the beams yielded by extension. In other words, the weakest part giving way first, up to experiment 5, the *top* was weakest, and in the remaining experiments the *bottom* was too small; the point at which the top and bottom were of corresponding strength, or the *strongest form* of beam, being when the bottom bears to the top the ratio of about 1 : 1·7.

* Somewhat anomalous: Mr. Fairbairn's remark in regard to it is, "top side doubled up, and sides bulged close to injured part."

In column 5 the breaking weight is reduced to unity of length, depth, and section; and hence the numbers represent the comparative strength of each arrangement of material, or the weight a given amount of wrought iron would sustain in each of the forms experimented on. This column shows that the strength increases from 0·78 to 2·39 or (threefold), as the ratio of the flanges increases from 2 : I to I : I½. There is no anomaly in this. In experiment 1 much material is completely wasted, and the strength per unit of section is reduced accordingly. In experiment 5 the distribution is nearly perfect, all the material has its powers taxed to the utmost, and the strength is correspondingly high. So, again, as the material in the top flange is still further increased, the strength per unit of section is diminished, and in 7 there is almost as ineffective a distribution of material as in 1.

Now, bearing in mind that these were experiments to determine primarily the relative strengths of various forms of beams, I ask any candid reader whether Mr. Hughes can maintain his assertion, that these experiments are "not a bit more consistent than he at first represented them," or that "such anomalies exist that it is impossible to decide with anything like confidence what is the proper coefficient to be taken." In the experiments on cast-iron beams, some bore as little as 2,300 lbs. per sq. in., others as much as 4,000 lbs.; yet Mr. Hughes had no doubt then that the constant was to be derived from the beams of the best form, rejecting altogether those in which the distribution of material is out of proportion. Applying the same rule to these experiments, and recognising from them the proper ratio of the flanges in these beams to be I·0 : I·7, we see that the only results which need be considered in deducing a constant, are (5) and (6). From these, and using $W = \frac{A\,d\,C}{l}$ in preference to Mr. Hughes's novel manner of stating the formula:—

(5) gives C = ...	28·6
(6) „ = ...	I7·8
Mean............	23·2

This constant is probably a little too low, neither of the beams being quite true in form; but that it is not far from the true value is singularly confirmed by the series of experiments on the model tube 75 ft. long, in which the top being made at first of enormous strength, in proportion to the bottom, the latter was increased by successive additions, until the best form was attained, the breaking weight being ascertained at intervals.

TABLE II.—*Breaking Weight of Model-Tube.*

No. of Exper.	Breaking weight in tons.	Area section, inches.	Ratio of bottom to top flange.	Breaking weight reduced to unity of length, depth, and area.	Gave way by,
1	35	41·8	1 : 2·73	1·16	Extension
2	43	45·8	I : 1·87	I·37	Twisting
3	56	45·8	1 : 1·87	I·69	Extension
4	66	50·8	1 : I·34	1·80	„
5	86	54*	1 : 1·07	2·I8	Compression

This series is singularly beautiful and uniform in its results. In experiment 5 the resisting powers of the bottom are within very small limits, equal to those of the top, and the material is distributed in its best form. Here, model tube 5 gives C = 24·4; and this result nearly agrees with C = 23·2, derived from the former table, whilst the experiment is on so large a scale, and the additions to the bottom flange so small in comparison to the whole area, as to obviate any ground of cavil. In one respect the above table presents a marked contrast to the former. In the model tube, the *top*, being cellular, is so well fitted to resist compression, and prevent the *buckling*, which affected the results on box beams, that it requires to be only 1-IIth greater than the bottom. This also explains why, for box beams, the constant derived from the whole area must, in every case, be slightly less than for tubular beams, each being of the best form. Had the top flange of beams 5 and 6, Table I., been as adapted to resist compression as in 5, Table II., and the area reduced in proportion, we should have obtained C = 24 nearly; a still closer coincidence between the two series of experiments.

Taking these experiments as a whole, I believe that the anomalies are by no means greater than in the celebrated series on cast-iron beams; and although fewer in number, they point as conclusively to a constant lying between the limits of 23·5 and 24·5 in the formula $W = \frac{A\,d\,C}{l}$, where A is the whole area, and W the breaking weight of cellular and box beams. The difficulties in obtaining uniform results were, doubtless, very considerable, both from the varying rigidity of the plates, and the impossibility of uniting them into a homogeneous mass.

Another series of experiments remain for consideration—viz., those on rolled iron and plate beams. These in every case gave way by lateral flexure, not being supported, as when ordinarily used by the thrust of arches. The results are, therefore, *lower* than if the beams had given way by extension or compression. The results are as follow:—[See Table III.]

The rolled beams in this table give a remarkably low constant. Mr. Fairbairn dismisses them with the remark that "they are obviously very inferior in strength to the hollow rectangular girders." Their resisting powers appear never to have been fully tested, as they bent laterally as much as 2½ in.; no doubt, in consequence of the *extreme narrowness of the top flange*; and it appears to have been deemed unsafe to continue the experiments further.

* Mr. Hughes has miscalculated this = 45, and has several errors in consequence.

TABLE III.—*Breaking Weight of Plate-Beams.*

	No. of Experiment.	Area section.	Ratio of flanges.	Breaking weight reduced to unity of length, depth, and area.	Constant C.	
Rolled	30	6·29	1 : 1·6	I·21	I4·3	Bent laterally
	3I	7·44	1 : I·4.	I·21	14·5	Distorted
	32	7·59	1 : 1·5	I·44	17·3	Bent laterally
Angle iron.	34	6·3	I : 0·9	I·72	20·7	Top rib twisted
	35	6·3	1 : 0·9	I·55	I8·7	Bent laterally

The remaining experiments are quite consistent with Table I., though it is perhaps to be regretted that there are no others on plate-beams with the flanges proportioned as in 25 or 15A, by which the constant thence derived might have been verified. Practically these experiments indicate the correctness of Mr. Fairbairn's reduction of the constant in the ratio of 80 to 60. This diminution gives C = I8, instead of 24, derived from Table I., exactly coinciding with the only reliable experiments in Table III.

Thus far I believe that I have vindicated the *perfect agreement* of this series of experiments, and am confident that the more closely they are compared the more their truthfulness and consistency will be shown; and, further, they appear fully to establish the ordinarily received constants—

	c	C	n
For tubular girders..............	80	24·5	2·0*
For large plate-beams	75	23·0	I·9
For small plate-beams unsupported laterally..........................	60	I8·3	I·5

London, January 13th. U.

* In this case the weight of the tube is taken into account, as more accurate than in the table above. The difference resulting is, however, slight.

STEAM-SHIP CAPABILITY, &c.

To the Editor of The Artizan.

SIR,—I am content to leave Mr. Mansel's vituperation, his visionary conceptions of *vis viva*, and what I have written, to the dispassionate judgment of your readers. He now tells us that *vis viva* is not "*force*, but the *effect of force*," which (seeing that VIS, in Latin, means *force* in English), is tantamount to telling us that *force* is *not force!* This effect, it would seem, is of a very complex and indefinite character, and is to be measured by the dynamometer, in conjunction with the thermometer, the electrometer, and also (Mr. Prater would insist) by the sonometer. This is, no doubt, very *recherché* and interesting; but, I think, bears very remotely indeed upon the cube theory under discussion.

We are referred also to some thermal phenomena; among them, the evolving of heat by pouring water into a pail. A very pretty philosophical "pearl," no doubt: albeit I have never heard of people keeping aloof from the basins of the Crystal Palace fountains on account of their warmth. According to travellers, "Thor's icy throne" might be where the Falls of Niagara "boil in endless torture." There, 33 millions of tons of water fall per hour, the leap of the Cataract being 133 ft., and the previous fall in the Rapids, 200 ft. Mr. Baker says, "The work of the water may be readily determined in horse power; that is,

$$H.P. = \frac{33000000 \times 2240 \times 333}{60 \times 33000} = 12432000.$$

The river, therefore, is capable of performing more work than twice the work of all the steam-engines in the whole world." According to "thermo-dynamics," the space beneath this sheet of water—the "aqueous arch" under which intrepid travellers venture—ought to be as hot as an oven: and tropical fruits and flowers ought to be perennial in the vicinity of the production of so much heat!

A word or two with regard to Mr. Mansel's formula. I have shown that the normal resistance of the *Rattler's* greatest transverse immersed section at a certain velocity would be 42,000 lbs.—the actual resistance of the ship was 6,000 lbs.; the effect of form thus taking off 6-7ths of the normal resistance. She might have had ends reducing the resistance to 3,000 lbs. Now, whether it is 3,000 lbs., 6,000 lbs., or 42,000 lbs., Mr. Mansel has no factor in his algebraic formula to represent this all-important and extensively varying effect of form; but "some small fraction whose value depends upon the form of the ends." True, practically we do not build vessels that encounter the maximum resistance referred to; our steamers are not prisms, or half cylinders; but we do build them of such various forms, some so bluff and others so sharp, that although "some small fraction" might accidentally do for one ship, a very large fraction would be required for another.

Let us consider this "small fraction" mathematically. Is it to be constant? If so, it is superfluous; the mere area of the midship section would do just as well without it. Is it to be varied? If so, Mr. Mansel does not drop the slightest hint how. I may be abused for it, but really I cannot help smiling at such a mathematical abortion.

He concludes a paragraph composed of sophistry, the most puerile imaginable, with the following sentence:—"Uniformly accelerated velocity of the same weight, drawing a plane through water, is, therefore, a physical impossibility, and its supposition an absurdity." Disregarding suppositions, let us look at facts. The Marquis de Condorcet, M. d'Alembert, and the Abbé Bossut

superintended a set of well-known experiments in France with falling weights, and they report that "the motion became perfectly uniform after a very little way." And Beaufoy's experiments in the Greenland Dock, with a falling weight, show the same result. His first Table, at page 2, shows that the weight went on falling at an accelerated velocity for about 56 seconds, and then the velocity became constant. Thus the floating body, drawn by a falling weight moves from rest to equable velocity through a stage of accelerated velocity, which, whatever may be its increments, must be, by the laws of dynamics, UNIFORM. But my position was this:—I contemplated the weights falling with a *constant velocity;* and I repeat that a 20-lb. weight falling with a constant velocity, drawing a floating body through the water at 10 ft. per second, must have the resistance of that body *reduced* to draw it at 20 ft. per second. And that a weight of 80 lbs. falling at 20 ft. per second, will draw a body through the water which has four times the resistance of the latter, and not of the former.

In other words, the quicker the weight falls constantly, the less work it does on the resisting body per foot. This truth I have shown to be incompatible with the cube theory.

Smeaton very justly states that the *raising* of a weight in a given time is the proper measure of *power.* I most cordially acquiesce in this statement. And Mr. Mausel quotes from him the following argument:—"For if a power can raise twice the weight to the same height, or the same weight to twice the height that another power can, the first power is double the second;" the *same time* in both cases being implied. A mass of matter raised twice the height in the same time, has a *doubled velocity;* and this, Smeaton says, requires a double power; thus the measure of power is as the increase of velocity. Contrast this with *vis viva* as defined by Mr. Mansel. He says, "This principle, in its simplest form, asserts that a material particle moving with any velocity, must, to produce that velocity, have had an amount of power expended upon it proportional to the product of its mass by the *square* of its velocity."

Which is right, Smeaton or *vis viva?* I anticipate some amusement from Mr. Mansel's attempt to reconcile his authority with his theory; to me they appear to jar irreconcilably.

I have called *vis viva* an *ignis fatuus.* It has led Mr. Mansel through strange "wandering mazes," and I feel strongly an inclination to follow him; but I must resist the allurement. Your readers will appreciate his attempts to botch up his blunders. I have sent you "Earnshaw," to test the accuracy of the uotation which he impugns. The symbol *m* represents mass in the abstract; the solecism "mass of a particle" has its origin in Mr. Mausel's ingenuity.

Now, Sir, I should be sorry to speak disparagingly of Davy's thermal experiment with ice; or even of Count Rumford making a kettle of water boil by the friction of a blunt drill—I revere such minds as those of Liebig and Farraday —admire the investigations of Mr. Joule; but I seek for my evidence of the resistance and capabilities of floating bodies in another direction.

I quote, in conclusion, a passage from Auguste Comte, which conveys a salutary hint.

"The tendency to *à priori* suppositions, drawn by us from analysis, where Newton wisely had reference to observation, has made our exposition of the science of Rational Mechanics less clear than those of Newton's days. Inestimable as mathematical analysis is for carrying the science on, and upward, *there must be first a basis of fact to employ it upon.*"

G. J. Y.

THE LAUNCH OF THE "LEVIATHAN."

To the Editor of The Artizan.

Sir,—The launch of the *Leviathan* having of late attracted a great deal of public attention, I venture to offer, for the consideration of your readers, the few following remarks on the means adopted to accomplish the same, taking the particulars of the arrangements from the November Number of The Artizan.

I wish, however, here to disclaim any intention of putting forward my opinions on the subject with a view to their adoption in the case of the *Leviathan,* for I am well aware that the present plan will be persisted in until the vessel is afloat, however tedious the operation may be; but I would take the *Leviathan* as a practical illustration, and simply argue therefrom, whether the means adopted were the best possible, or would be so for any similar undertakings that may hereafter occur.

By referring to The Artizan, as stated, it will be found that the pressure on the wrought-iron plates and rails on the launching ways, taking weight of *Leviathan* to be 12,000 tons, would amount to about 30 tons per square foot, or 4 cwt. per square inch on the surface actually in contact. With this insistent pressure the total *friction,* supposing no unguent to be supplied, would not be less than 5,000 tons, according to experiments made by M. Morin; but the accelerating force on the inclined plane, which is 1 in 12, = 1,000 tons, ∴ *resistance* to be overcome = 4,000 tons; but allowing the surfaces to have a small amount of unctuosity, the *resistance* would be reduced to 1,000 tons; it is, however, evident that this might at any time be increased, and from the arrangements of the parts, and the excessive pressure—viz., 4 cwt. per square inch—it is most likely to be so: consequently a force equal to 4,000 tons should be provided to meet all contingencies.

The errors which I perceive, therefore, to exist in the present arrangements are:—First. The amount of surface in contact is too small; it is, moreover, too divided, *i.e.,* in separate bars and plates, not close together, whereby the unguent is not retained between the surfaces, but forced into the spaces beside them. Secondly. The mechanical power required is enormous. The nature of the arrangements for supplying the requisite amount of power is likewise faulty, inasmuch as no provision is made to produce continuous motion, the result of which is increased friction after every stoppage, and a large amount of money spent in labour, the operation extending over several weeks.

To obviate these existing evils, the power required should be reduced to a minimum, which it certainly is not at present: for 4,000 tons resistance is a very large amount to have to provide for, and the surface should be increased and so formed that the unguent supplied will remain between the cradles and the ways, which it cannot now possibly do.

I suggest, therefore, that by forming plane surfaces of 75 feet in extent on each of the present ways (in the longitudinal direction of the vessel), either in wood or iron, the bottoms of the cradles being treated in a similar manner, the surface in contact would then amount to 6,000 sq. ft. in each way, instead of 200 sq. ft., as at present, and the insistent pressure would be 1 ton per square foot, instead of 30 tons. With a proper coating of tallow, which would remain between the surfaces, the *friction* would be 600 tons, instead of 5,000 tons, as at present; but the accelerating force on the inclined plane remaining 1,000 tons, there would be, instead of 4,000 tons *resistance,* an excess of *force* on the inclined plane = 400 tons.

Let but the 400 tons be amply provided for, in the shape of efficient check tackle, and the magnificent vessel might be gently and safely lowered down to the extremity of the ways in a few hours, and thence floated off as arranged.

I must add that experiments should be made, on a sufficiently large scale, to determine whether the 400 tons here deduced would be the exact amount for which to provide; and should 400 tons be considered too great a force to deal with, a slight difference in the inclined plane would reduce it to 200 tons, which force I consider would be sufficient to launch the vessel.

The necessary alteration in the inclined plane, to reduce the excess of accelerating force over friction to 200 tons, would be to make it 1 in 15, instead of 1 in 12.

I am, Sir, your obedient servant,

Greenwich January 11, 1858. W. B.

LAW CASES.

THOMAS *v.* FOX.

In this case, which was an action for the infringement of the Plaintiff's patent for a sewing machine, and which has been already twice tried, and the verdicts found for the Plaintiff, Sir F. Kelly moved for a rule to show cause why the verdict found for the Plaintiff at the last trial should not be set aside, and a new trial granted, on the ground that the verdict was against the weight of the evidence. He also moved, pursuant to leave reserved, for a rule to enter the verdict for the Defendant. Lord Campbell said the learned counsel might take a rule to show cause. His lordship, in very strong terms, condemned the practice which prevailed in patent causes of giving notice of such numerous objections to patents, and hoped that rules of Court would be made, whereby such notices should be required to be signed by counsel, as a means of checking the abuse.

Rule *nisi* granted.

THE ATTORNEY-GENERAL *v.* BARRY.

This case was tried before Mr. Baron Bramwell, when a verdict was found for the Crown. Sir Fitzroy Kelly (with whom were Mr. Bovill, Q.C., and Mr. Welsby) now moved for a rule to show cause why the verdict should not be entered for the Defendant, or a new trial granted. This was an information at the suit of the Attorney-General, claiming penalties from the Defendant for carrying on business as a paper manufacturer without a license. In the year 1854, a person named Brown obtained a patent for "making artificial skins for the manufacture of parchment, &c." The real question at the trial was, whether the article so manufactured under the patent, was paper within the meaning of the Act of Parliament, which imposes a duty of 1½d. per lb. on the manufacture of paper, and requires the manufacturer to be licensed. In the process of manufacture, the hides are reduced to a pulp in precisely the same manner as rags are in the manufacture of paper, and then the parchment is produced. A specimen of the Defendant's manufacture was handed up by Sir Fitzroy Kelly to Mr. Baron Martin, when his lordship said that be should say the specimen was parchment, and not paper, and that the former was not subject to a duty.

Rule granted.

FATAL BOILER EXPLOSION.

A boiler explosion, which resulted in the deaths of three persons, has occurred at the Aberychan Iron Works. The boiler belonged to the winding engine of one of the pits, and was of large size, and formed of massive plates of iron. About 12 o'clock the engineer who attended to it turned the top cock on, and the water flowed out, showing that it did not require replenishing. A few minutes afterwards the catastrophe took place, from what cause is not yet ascertained. A man who was feeding the fire was so severely hurnt that he died very soon afterwards; and two boys, who were walking about 15 yards off, were hurled a distance of 30 yards, and instantly killed. A piece of the boiler, weighing about 2 tons, was forced away the same distance, and another fragment, weighing about 2½ tons, was carried 20 yards away, where part of it lies firmly embedded. Some small pieces were even found at a distance of 300 yards. The boiler-house was completely demolished.

NOTES AND NOVELTIES.

MISCELLANEOUS.

Messrs. Maudslay and Co. have provided, for the use of their workmen at Lambeth, a spacious reading room and mess room.

A Directory of Canada has been recently published by Mr. Lovell, of Montreal.

Calcutta is now lighted with gas.

We regret to announce the death of Mr. John Henderson, of the late firm of Fox and Henderson, at Helvin Grove, near Birmingham. Mr. Henderson was in the 47th year of his age.

Newspaper Articles may not be copied into other journals in Denmark without acknowledgment. This is under the new law of the press.

January 15th the compulsory prepayment of postages was extended to all letters addressed to the following colonies:—Malta, Gibraltar, Hong Kong, Jamaica, Antigua, Demerara, Berbice, Bahamas, Honduras, Dominica, Montserrat, Nevis, St. Vincent, St. Lucia, St. Kitts, Tortola, Tobago, Curaçoa, and Grenada. Letters posted in the colonies mentioned, addressed to the United Kingdom, required to be prepaid.

Coals to London.—1,246,299 tons were conveyed by railway to within 20 miles of London in the year 1856, and 1,206,775 tons in the year 1857, showing a decrease of 39,524 tons.

Alloy of Chromium. — M. Fremy has obtained an alloy of chromium and iron, by reducing chromate of iron with charcoal under a high heat in a crucible. The alloy is very hard, and resembles brass.

Practical Engineers.—We understand that measures are being adopted to organise an engineering club in London. A preliminary meeting will shortly be held, at which, among other matters, it will be proposed to include every branch of engineering science, whether in mining, railways, or canals. Amongst the objects in contemplation are an extensive library and a lecture theatre for the convenience of the members.—*Mining Journal.*

Strata of Auriferous Soil have been discovered at Lingenfield, on the Rhine.

An Immense Mass of Alum Shale, excavated from a mine at Westerdale, York, has spontaneously ignited, and is emitting vast volumes of nauseous vapour

A New Chimney, in connection with the works of Messrs. Crossley, at Dean Clough, which will be of extraordinary dimensions and weight, is nearly completed. Although placed in a valley, it has attained a level with the summit of Beacon Hill. Its height is 127 yards, the width at the bottom being 10 yards. The weight of brick and stone used in the erection is estimated at 9,685 tons.

College for the Working Classes.—It is proposed to found colleges in various parts of the metropolis for working men and their families. The first of these institutions will be forthwith establish.d in the parish of St. Anne, Soho. Attached to the college will be a free library and reading-room for the working-men, a public lecture-hall, and a chapel.

RAILWAYS.

The East Kent Line has been inspected prior to being opened for public traffic. Mr. Brassey is stated to have undertaken the construction of the Worcester and Hereford. The estimated cost of the following new lines, &c. is ;—South Wales (to Pembroke Dock, &c.), £250,000 ; Belfast and County Down, £250,000 ; Stockton and Darlington, North Riding Lines, and Bridge over the Tees, £147,746 ; Border Counties Extension, £90,000 ; Merthyr Junction, £80,000 ; new branches and improvements of Whitehaven Junction, £65,000 ; Mid Kent, Croydon Extension, £40,000 ; Stockport, Disley, and Whaley Bridge, to Hayfield, £35,000 ; Burton-on-Trent, £20,000 ; and East Suffolk Branch, £10,000. A satisfactory conference has taken place between deputations of the Boards of the Birkenhead, Great Western, London and North Western, and Birkenhead, Lancashire, and Cheshire Junction Companies, on the question of the new Birkenhead Dock plans. Arrangements were mutually agreed on, and it is believed that one of the conditions is that the works shall be completed within six or seven years. The shareholders of the South Staffordshire have accepted the terms of an agreement for leasing their property to the London and North Western

New Works of the London and North Western Railway.—The financial declaration of the directors of this company to Parliament has been made in respect of the new powers they seek for in the ensuing session to make extensions of their line from Longsight to Hyde and Stalybridge ; to make a branch and alter canal at Shrewsbury ; to make new roads at Willesden, Watford, Coventry, Crewe and Stafford ; to make new works at Coventry and Nuneaton ; to abandon part of St. Alban's branch ; to take additional lands at Linsdale, Northampton, Pitsford, and in Manchester and Salford, and to widen the bridge over the Irwell

The proposed West End Railway Terminus will occupy the most central position in Westminster and Pimlico. It will be within 400 yards of Buckingham Palace, 800 yards of Belgrave Square, 1,100 yards of Hyde Park Corner, 1,100 yards of Westminster Abbey, and 900 yards of Pall Mall. As the line will pass along the Grosvenor Canal, a dead level will be obtained for the railway, and the extent of accommodation at the terminus is magnificent for railway purposes.

Brentford and Richmond.—The estimated parliamentary expense for constructing the new line, as certified by the engineer, is £80,000.

Stockport, Disley, and Whaley Bridge.—The estimate of the Company's engineer for constructing the proposed railway to Hayfield, is £35,000.

Merthyr Tydvil.—Estimated cost of constructing new line and works, including purchase of land, &c., £80,000.

Manchester, Sheffield, and Lincolnshire.—This company propose constructing a new line from Newton to Compstall ; their engineer, Mr. Russell, reports that it will cost £130,000.

Manchester, Sheffield, and Lincolnshire.—During the past half-year the contractor for the permanent way has taken up the whole of the stone blocks on the line, and completed the fishing of the permanent way between Manchester and Retford, on both lines, with the exception of three miles of single line. The works in progress are—the Graving Dock at Grimsby, which is expected to be completed by the 1st of February, upon which £25,112 has been expended; a new hoist, at Manchester, estimated to cost about £3,850; extensions of sidings at Ardwick, estimated cost £2,000, which are expected to be completed by the end of February. A new warehouse has just been completed at Ardwick, at a cost of £1,900. The short branch to Hyde is in course of completion, and is estimated to cost about £6,500. The curve at Lincoln to connect the Midland and Great Northern lines is also in progress.

Guerin's Brake.—A trial of these brakes is about to be made on the South-Western Railway.

Border Counties Extension.—The engineers of this line, Messrs. Tone and Charlton, have estimated the cost, including land, at £90,000.

London Tramway.—The estimated expense by Mr. J. Samuel, the engineer of this undertaking, including contingencies, is reported to Parliament to amount to £31,000.

London, Brighton, and South Coast.—The cost of the proposed new lines of this company from Shoreham to Henfield, to join the Mid-Sussex Railway, is estimated, including the purchase of land, at £155,000.

Andover.—The works required to convert the Andover canal into a railway, including the construction of the proposed new line, are estimated at £130,000.

South Wales Railway.—The financial statement of the directors of this company to Parliament in respect of their proposed new railway to Pembroke Dock, additional land at Newport, and extension of power of leasing to Great Western Railway, sets forth that the expense thereof will be defrayed out of a surplus of £260,000, remaining unexpended out of the £4,800,000 which they have been authorised to raise.

Caledonian.—The cost of the construction of this company's branch railway, from the Clydesdale junction, near Rutherglen, to Dalmarnock, is estimated at £36,850.

Carron.—The estimate of the engineer for the construction of this line from the Stirlingshire Midland Junction to the Carron Works, is £13,000 for the railway, and £5,000 for the canal.

France.—The section of the Bourbonnais Railway, comprised between Roanne and La Palisse, is to be opened to the public in the course of the month of March next. The opening of this section, which is the only gap which exists between the Bourbonnais and the most direct line from St. Etienne to Paris, will shorten the distance between those towns by 30 miles. The section between Langres and Vesoul, which has been inspected by Government engineers, will be open to the public in a few days. The section from Vesoul to Mulhouse is so far advanced that it may be opened to the public within three months.

Paris to Mulhouse.—The section from Belfort to Dannemarie will be opened for passengers on the 15th February. A direct communication from Paris to Mulhouse will thus be opened through Troyes, Chaumont, Langres, Vesoul, and Belfort. The section from Seyssel to Bellegarde, on the Lyons and Geneva Railway, is almost finished. The torrent of L'Hôpital, of which the deep and rugged banks present an interruption of some extent above the aqueduct cut in the rock for the waters to run off, is entirely filled up. The works of the tunnel of Surjaux, favoured by fine weather, are finished, and thus all the difficulties are overcome. The handsome viaduct of the Vegerance will be shortly finished. The road is already open from this point to the terminus of Bellegarde.

The Athenian Railway.—The concession of this line of railway has been given to a French company

The Italian Railway Company (*Compagnie du Chemin de Fer de la Ligne d'Italie*) has obtained from the Sardinian Government and the State Council of the Canton of Geneva the following concessions:—1. Line from Geneva to the Sardinian frontier. 2. The Chablais line, from the Genevese frontier to the extremity of the Lake of Geneva. 3. The lines of the Haut and Bas Valais, from the eastern end of the Lake of Geneva to Brigg at the foot of the Simplon. 4. The Simplon Pass Railway, from Brigg to Domo d'Ossola. 5. The Lac-Major Railway, from Domo d'Ossola to Arona.

BRIDGES.

The Victoria Bridge at Montreal.—The place where this bridge crosses the St. Lawrence is about half a mile to the westward of Montreal, a short distance below the "Lachine" Rapids, and about 9 miles from St. Anne's, the place immortalised in Moore's "Canadian Boat Song." The total amount of masonry in the bridge will be about 3,000,000 cubic ft., which, at 13½ ft. to the ton, gives a total weight of about 222,000. The total weight of iron in the tubes will be 10,408 tons. The material for the second tube has reached Canada ; and preparations are in progress for the despatch, from England, of eight more tubes, so as to insure their erection next summer. Mr. A. W. Ross, the engineer, having completed his duty as Engineer-in-Chief of the Grand Trunk Railway, now directs his skill and attention exclusively to this structure. The bridge will cost about £1,250,000. The first tube has just been placed in position. It weighs nearly 1,000 tons, and when left to support itself deflected only 1½ in.

Westminster New Bridge.—The works of Mr. Page's new bridge are now rapidly progressing. The whole of the piers will soon be completed above high-water level.

Fall of the Chain Suspension Bridge over the Severn at Caerhowell, near Montgomery, North Wales. Two waggons, laden with lime, with their teams, were passing at the time. The chains instantaneously gave way, without any warning, precipitating the waggoners, waggons, and horses into the river. One of the waggoners was drowned. The bridge was of cast iron, built about two years ago, at a cost of £2,000. An examination of the bridge will be made, and an inquest held on February 3rd.

The New Iron Lattice Bridge crossing the river Taff at Pontyrhun, of about 90 ft. span, has now been completed. The work was executed by the Usk Side Iron Company, under the direction and superintendence of Mr. J. W. Harrison, surveyor to the Merthyr Tydvil Board of Health.

TELEGRAPH ENGINEERING.

Atlantic Telegraph.—The bill of this company, to be laid before Parliament, proposes an increase of capital by the creation of new shares, and the borrowing, on mortgage or bond, the original capital of £350,000, now all paid up, being found, "in consequence of circumstances beyond the control of the company," inadequate for the purposes of the undertaking.

The Submarine Cable in the Straits of Messina is broken. The operation of laying it down is to be recommenced.

A contract has been entered into between the Government and a telegraph company to unite Greece, by means of the electric cable, with the Ionian Islands, and thence with Trieste on the one hand, and, on the other with Turkey and Vienna by Syria and Constantinople.

The United States Steam Frigate "Niagara" will again be employed in laying down the Atlantic Cable in June next.

Australia.—It is proposed to connect Tasmania with the Australian continent by means of a Submarine Cable. The telegraph will be shortly completed between Adelaide and Melbourne. A great project has been mooted at the latter place for securing telegraphic communication with London

The Telegraph from Malta to Corfu.—The *Elba* took three days to complete the operation. The route taken by Mr. Newall was that of keeping as near to the coast of Italy as possible, owing to the great depth in the direct course between Malta and Corfu. Opposite Mount Etna the depth was found to be immense. The weather was very favourable, and the submergence was effected most successfully.

MILITARY ENGINEERING.

Plymouth.—Major Jarvis, Assistant Inspector-General of Fortifications, is at Plymouth, on special duty, to make arrangements with the Earl of Mountedgcumbe and Mr. W. Pole Carew, for the purchase of portions of their lands for the purpose of constructing a chain of ortifications on the western side of the town.

Defences for the Coast of Scotland.—We understand, says the "Aberdeen Herald," that the arrangements between the Town Council and the Government for the protection of this city and harbour have been completed. There are be three batteries—one, a four-gun battery, will be erected on the Links, near the sea-beach, opposite to Garvock Street, commanding the bay and entrance to the harbour; another on the site of the old North Pier Battery, to be armed with one gun of the heaviest calibre, to command the approaches ; and the third, a nine-gun battery, on the town's lands at Torry, near the fShortness, covering the entrance and approach into the harbour.

HARBOURS, DOCKS, CANALS.

The King and Queen of Greece went to Chalcis on the 29th December, to inaugurate the opening of the canal of Eubœa, which is brought to a successful termination.

The Suez Canal, Constantinople. — M. de Lesseps arrived last week from Trieste, just at the period of Lord Stratford's departure. In the firman given by the Porte to Mehemet Ali of Egypt, the latter is obliged to obtain the consent of the Porte to all public undertakings of any magnitude. This M. de Lesseps is now assiduously striving to obtain.

The amount of the estimates for the completion of the Birkenhead Docks is £1,700,000; this, with the present debt of £1,300,000, will raise the debt to £3,000,000.

Harbour at Peterhead.—A deputation from the parliamentary trustees of the harbour of Peterhead, in Aberdeenshire, have been visiting Newcastle and Sunderland, with the view of eliciting an expression of interest on the part of the public bodies in favour of a harbour at Peterhead, for serving the purposes of refuge in Scotland. Such an undertaking is of course only expected after Parliament has sanctioned a similar harbour for the more southern coast, and from the trade betwixt Newcastle and the north of Scotland. We have little doubt that the subject of a harbour of refuge for Scotland will meet with the attention which it deserves.

Sunderland Harbour.—Mr. R. Stephenson has visited the Port of Sunderland, under the request of the River Wear Commissioners, with a view to the immediate improvement of the bar and harbour. The eminent engineer was supplied with elaborate plans, drawn by Mr. Meik, the Commissioners' engineer, and a thorough survey was made ; after which Mr. Stephenson had an interview with a Committee of the Commissioners, the result of which will be that the contemplated work will be commenced without delay.

MARINE ENGINEERING, SHIPBUILDING, &c.

The Shipbuilding Department at Chatham Dockyard now presents great activity, in consequence of an Admiralty order which has recently been received, directing the completing, with all despatch, of the screw steamers, and other vessels now constructing at that establishment, in order that several additional large steamers may be laid down.

The American Steamer *Ariel* has put back to Queenstown—mainshaft broken.

The Australian Postal Service.—The Government have allowed the Glasgow company quietly to be absorbed into the Royal West India Mail Company; not only so, but without public competition have renewed the contract with the West India Mail Company, and now pay them yearly £455,000.

Broadside Ship Launches.—At Maryport, Cumberland, this mode of launching vessels has been practised for about fifty years.

The wreck of the steamer *Rapid*, lately sunk of Great Yarmouth, has been inspected by divers. Some of the cargo may be saved.

The Strike of the Wear Shipwrights has terminated.—The men are to get the old wages of 5s. per day.

Launches on the Wear.—During the first four days of the new year thirteen vessels were thrown off—an aggregate tonnage of 6,000 tons.

The passage through Torres Straits is growing up very fast with coral islands and reefs. Few ships attempt it now.

The *Victor Emmanuel*, 91 screw two-decker has been fitted for trial with a new four-bladed propeller.

The affairs of the Australian Steam Clipper Company are to be wound up.

Irregularity of the French Mails.—Great complaints are being made about the irregularity of the French mails to the East. This irregularity is due, it is said, to the new class of vessels employed by the Company of the Messageries Imperiales, which have proved a complete failure.

Weekly Steam Communication with India.—The Peninsular and Oriental Company intend to despatch four steamers per month from Southampton to Alexandria instead of two, as at present. This important extension of the company's operations will of course demand an increased number of steamers. To meet this demand, four or five new steam ships will be ready during the next three or four months: the *Malabar*, 1,080 tons; the *Benares*, 2,500 tons; the *Salsette*, 1,500 tons; and the *Northam*, 1,500 tons, now building at Messrs. Summers and Day's yard, Southampton. In addition, the *Malta* (paddle), is being converted, at Glasgow, into a screw steamer, and her new boilers are being made at Birkenhead.

The total number of wrecks during the past year was 2,002.

The Amoor River.—The Russian Government have had two iron steamers built in Philadelphia. They were brought out in two sections, and erected during the winter. They are small boats intended to run a distance of 2,200 miles up the Amoor. The Russians expect to have three more next year. There are two American engineers in the employ of the Government upon this river.

London, Isle of Dogs.—Some eighteen months since the eight acres upon which the works of Messrs. Westwood, Baillie, Campbell and Co., have been erected, were simply brick-fields. During the period mentioned, the firm have erected an extensive range of workshops, in which are to be found all the conveniences of drilling machines, punching presses, lathes, and, in fact, everything necessary for carrying on a large trade in ship-building, wrought-iron bridges, and other works. The firm have turned out, during the eighteen months, 2,000 tons of iron bridges tor the East Indies. They have completed other bridges and pontoons to the extent of 1,000 tons, and constructed the landing pier at Milford Haven for the *Leviathan*, a work which has met with the entire approval of Mr. Brunel; they have built three vessels, a caisson for the East and West India Dock Company, and 40 mud vessels for the Turkish Government. These were turned out within two months, with other works, including a number of steam boilers.

Progress of the Launch of the "Leviathan."—*Jan.* 5.—At 5 o'clock, when work was discontinued, she had made 26 slips in all, in lengths varying from 2 to 5 in. each, according as the pressure was great and the elasticity of the timber threw her off with more or less force. Her whole progress was 8 ft. 3½ in. aft, and 3 ft. 1 in. forward. The reason of this great difference between the progress of the stem and stern is, because the fore part of the vessel is already so much in advance as to have twisted the cradles on the ways. In addition to the admirable arrangement of joining the rams in threes, each machine is now fitted with a pressure gauge, which records the exact weight per circular inch on each ram. Each ram also, though nearly all are capable of bearing a pressure of four or five tons to the inch, has been gauged, and the escape-valve so weighted as to let out the water at a pressure of 30 cwt. to the inch. With these precautions, it is next to impossible that they can now be burst. The united pressure of all the 21 rams now fixed, and working at 30 cwt. the circular inch, would amount to no less than 4,000 tons, which, as the resistance of the *Leviathan* has never yet been known to exceed 1,900 tons, is of course more than double the force they are likely ever to be wanted to exert. From a record kept yesterday of the pressure upon the rams when each slip was made, it seems that the average strain required to move was 1,300 tons. The variations above and below this standard, however, were constant, and occurred in a most unaccountable manner; sometimes she slipped when the register barely reached 1,000 tons pressure, and then probably at the next movement a force of 1,700 tons was exerted before they could get her to move an inch.

Jan. 6th.—Operations were resumed, as usual, at Millwall, and continued without interruption throughout the day, when the signal board showed a further progress of 10 ft. aft, and about 9 ft. 6 in. forward. During the previous night the precaution had been taken of completely emptying all the hydraulic machines with their pumps and feed pipes, so that none were frozen; and the whole apparatus was at work at 9 o'clock. The pressure exerted on Tuesday, never exceeded 1,700 tons, and the vessel even slipped at as low a force as 1,000 tons; the average of the whole day being about 1,300 tons. Yesterday the average pressure exerted showed a decided increase of resistance on the part of the ship to the amount of nearly 200 tons; and, in one or two instances, the strain required to overcome it was almost double in amount to that at which she had slipped the previous day. At the first starting at 9 o'clock, she never slipped at all, but ground slowly down the launching ways at the rate of about an inch in four or four-and-a-half minutes. At this rate she continued to progress slowly, but very steadily, till the men left for dinner. When the efforts were resumed, after an hour's interval, it was found at once, that from some unexplained cause or another, she had abandoned her slow mode of grinding down and taken again to short slips from 2¼ in. to 5 in. in length, the average being about 3 in. As was the case on the day previous, the pressure gauges on the hydraulic rams at each slip showed that the weight of the vessel overcome the elasticity of the wood, and left a pressure of 2 cwt. to the circular inch on each machine. Judging from this, it is evident that a slight continuous strain would suffice to keep her in motion for a distance of probably 1 ft. or 2 ft. The hauling tackle towards the river was not used, at least the steam power was not applied to it, though a few men at each end worked it with a fourfold purchase, and at the stem, at least, again exerted sufficient strain to crush in the iron drum of the windlass.

Jan. 7th.—11 ft. was accomplished on the fore and aft cradles. The whole of this distance was traversed by the gigantic vessel in a series of short grinding slips, varying in length from 3 to 6½ in., and taking place at regular intervals of ten minutes or so between each. The amount of pressure exercised by all the hydraulic machines varied from about 2,000 to nearly 2,500 tons; the average, however, showing that the resistance offered by the ship was rather less than on the previous day. The river tackle was only used to a very limited extent.

Jan 8th.—Advanced 12 ft. 8 in. aft and 11 ft. forward. The vibrations more violent and continuous than before.

Jan. 9th.—The launching was continued as usual, and resulted in a further advance of 10 ft. fore and aft. The fore part of the vessel seldom moved until all the forward hydraulic presses were worked up to the full power which they are now allowed to attain, namely, 30 cwt. on the circular inch. The aftermost cradle, on the contrary, was, as usual, much inclined to slip, and generally started when the pressure of the rams at that end had reached 21cwt. or 23 cwt. on the inch, The fore part on Saturday therefore gained considerably on the stern, for, the compression of the wood forward being very great under the heavy strain, when the monster did slip, its expansion naturally forced her down a greater distance in the ways than at the after part, where the effect of the pressure was lost in the movement of an inch or so.

Jan. 11th.—An average advance of 20 ft. was made in the course of the day, the gauges on the hydraulic presses seldom indicating a pressure of more than 20 cwt. per circular inch at each slip; vibration diminished.

Jan. 12th.—Before dinner time 20 ft. was accomplished in almost continuous movement of short slips. The gauges on the hydraulic presses registered 15 cwt.

Jan. 14th.—A short time before the tide had reached its highest, three of the hydraulic machines aft, and three forward, were set to work to move the vessel nearer down the ways. She moved in quick short slips, with the utmost ease; the gauges of the few hydraulic machines in use seldom averaging more than 10 cwt. to the inch, and each slip taking place at short intervals, and with an almost total absence of vibration. In a comparatively short time a distance of 13 ft. aft and 3 ft. 5 in. forward was accomplished, the after part showing such a tendency to slide away on the least pressure that it was impossible to regulate the ship's movements with the same relative accuracy as heretofore.

Jan. 23rd.—The moving of the *Leviathan* to the extremity of the ways, where she will be left to float at the full spring tide of Saturday next, the 30th inst., was resumed this morning, and attracted an unusual number of royal visitors. The operations were recommenced at half-past 7 o'clock, Mr. Brunel, Mr. Hepworth, Captain Harrison, and Mr. Prowse being at their respective posts. The ship moved readily on the pressure of the hydraulics being applied, owing, no doubt, to her having several feet of water under her. She progressed nearly 3 ft. in the first hour. As the tide receded, however, the power had to be considerably increased, and frequently it was only on the almost full pressure being put on that she advanced. This is accounted for partly by the mud which had accumulated at the end of the ways, by the falling tides, and the distance the ship has progressed from the rams, from some of them as much as 150 ft., the ram-heads which run from the piston of the ram to the cradles being formed of heavy baulks strongly bolted and ballasted to prevent the tide floating them from their position. When the men ceased operations in the afternoon, the ship had advanced upwards of 8 ft. during the day, which, with Friday's work, brought her down some 16 ft. more than when the work ceased some 10 days ago. She is now within a few feet of the very extremity of the ways, and at the ensuing spring tides she will have amply sufficient water under her to be fairly floated. Indeed, on Wednesday, when there was a very good (neap) tide, she showed very lively symptoms of freeing herself from bondage, and, as if anxious to bound into her future element, was seen to lift at her stem and stern. As a matter of precaution to check her buoyancy, 1,500 tons of water was put into her compartments to keep her down.

Mr. Daniel Russell, the nautical engineer who saved the royal mail steamer *Tyne*, after grounding near St. Alban's Head, offered his services to launch the *Leviathan* in a month's time, at a cost not exceeding £5,000 or £6,000, "provided all the machinery and gear now in use be cleared away."

THE GREAT EASTERN STEAM-SHIP "LEVIATHAN."

We have the satisfaction of being able to inform our readers that this ship has, at the time we write (the 28th January), been successfully pushed down some 20 ft. beyond the extreme end of the launching-ways, where she remains awaiting a sufficient rise of tide at high-water to float her off clear of the cradles, &c. The tide this day (28th) was sufficient to lift the vessel and after cradle slightly off the after launching-way; yesterday at noon there was within 3 to 6 in. sufficient depth of water. The cradles are being taken to pieces, so as to enable the ship to be more easily hauled off.

Four of the most powerful steam tugs employed on the Thames have been engaged by Captain Harrison to be in readiness to-morrow to haul her off and take her in tow. We have been informed that the tugs engaged are, the *Victoria*, the *Napoleon*, the *Friend of All Nations*, and the *Perseverance;* a very appropriate selection of names for the occasion.

We have, therefore, every reason to believe that about the time the February Number of The Artizan is in the hands of our provincial subscribers, the *Great Eastern*, or *Leviathan*, will be safely moored off Deptford.

NOTICES TO CORRESPONDENTS.

J. E. B.—Taylor and Co., Britannia Works, Birkenhead. We know of no other manufacturer.

Q.—Mr. Bright is still the Engineer to the Atlantic Telegraph Company; and Mr. Everitt, the Chief Engineer of the *Niagara*, U. S. steam frigate, has been appointed by his Government to co-operate with Mr. Bright in making arrangements for the laying down of the Atlantic Cable.

R. S.—We are informed by Mr. A. D. Mills, of Crane Court, Fleet Street, that S. B. Rogers's work upon Iron Metallurgy, is not yet issued to the public.

C. K.—Your inquiry is not of a character which we can reply to through The Artizan. If we were to answer such inquiries, and advise as to where to seek employment, &c., we might easily fill the twenty-six pages of the present Number. Had you complied with the rule to be observed by correspondents addressing us—viz., to send their correct name and address—we should have been enabled to reply through the post, which we are willing to do when we can be of any service to our subscribers. Do this, and we will write you at length, and give our best advice.

W. H. Nash.—The subject you wrote to us upon some time ago will be treated of very shortly. We are preparing numerous interesting facts connected with the subject.

Radix.—There are no specific rules for the length of the link in "link-motions." The action of the link, in regulating the movements of the valve, is substantially the same with any length of link. But it is plain that the shorter the link the greater is the angularity or obliqueness of its action on the valve-rod connections; and, in order to reduce this angularity, and the consequent angular strain, to the lowest limit, the link should be made as long as may be convenient.

Radix (No. 2).—The subject upon which you wrote a short time ago would require too long a reference to permit of our giving it here, and having lost your address, think it best to refer you to D. K Clarke's excellent work on Railway Machinery, where the subject is treated at considerable length, in the first part of Section 2, pp. 38—53.

A. Löwenthal, V., Q. C., and others, whose communications are not inserted in the present Number, shall be inserted in our next.

Vulcanized India-rubber.—An esteemed foreign correspondent, H. C. B., makes the following inquiry:—"Having to construct large pumping works requiring a considerable quantity of vulcanized India-rubber, I wish to know a good means for testing the quality of this material, and of the efficacy of the vulcanizing. Accordingly, I will feel much obliged on being informed, through your valuable Journal, if such a test is known, and how it is to be applied."

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 11th August, 1857.

2147. R. Husband, Manchester—Hats.

Dated 20th August, 1857.

2213. G. Spill, Stepney-green—Treating fabrics employed in the manufacture of hats, caps, and bonnets, and for other purposes, so as to render the same impervious to moisture and grease.

Dated 18th September, 1857.

2428. G. E. Dering, Lockleys, Hertford—Laying down electric telegraph cables, in obtaining soundings, and in ascertaining the position of and raising submerged electric telegraph cables and other bodies.

Dated 19th October, 1857.

2666. J. Schmidt, Essex-street, Strand—Making tyres for railway wheels.
2668. M. F. Cavalerie, 39, Rue de l'Echiquier, Paris—Motive power.

Dated 21st October, 1857.

2687. J. B. Slawson, New Orleans, U.S.—Boxes for receiving the fares of passengers in public conveyances, for the prevention of fraud on the part of the persons authorised to attend to the receiving of the fares as well as on the part of the passengers.

Dated 2nd November, 1857.

2784. J. Apperly and W. Clissold, Dudbridge, Gloucestershire—Feeding fuel to furnaces.

Dated 3rd November, 1857.

2786. P. A. le Comte de Fontainemoreau, Paris, London, and Brussels—Marine or condensing steam engines.
2794. A. C. Sacré, Brussels—Measuring water.

Dated 5th November, 1857.

2806. G. R. Simpson and D. C. Simpson, No. 78, High-street, Whitechapel, and No. 5, George-terrace, Commercial-road—Spring blinds.

Dated 19th November, 1857.

2906. P. E. Coffey, Bromley, Middlesex—Distilling.

Dated 24th November, 1857.

2935. E. O. Bordas, 36, Bond-street—Billiard cues.

Dated 25th November, 1857.

2942. F. Lemaire, Tavistock-st., Covent-garden—Petticoat.
2944. F. H. Maberly, Stowmarket, Suffolk—Polishing machine.
2946. C. Bernard, 39, Rue de l'Echiquier, Paris—Heating apparatus.
2948. E. C. Tisdall, Holland Park Farm, Kensington—Fluids containing animal and vegetable substances.

Dated 26th November, 1857.

2950. W. Blinkhorn, Sutton, near St. Helen's, Lancashire—Grinding, smoothing, and polishing glass.
2952. J. F. Shoner, 4, Church-street, Kennington—Common road carriages.
2954. J. Ruston, J. Toyne Proctor, Lincoln—Dressing grain.
2956. W. B. Taylor, Ballymena, Antrim, Ireland—Driving looms for weaving.

Dated 27th November, 1857.

2958. S. B. Wright and H. T. Green, Rugby—Bricks, pipes, and tiles.

Dated 28th November, 1857.

2960. B. Peech Leicester—Bedsteads, elastic bed bottoms, the seats of chairs and sofas.
2962. J. Peters, Eupen, Prussia—Spinning.
2964. A. A. Chassepot, Paris—Breech-loading fire-arms.
2966. R. Tindall, jun., Fraserburgh, Aberdeen—Harpoon guns and ammunition.
2968. F. G. Grice, West Bromwich, Staffordshire—Manufacture of bolts, spikes, rivets, screw blanks, and other articles of like manufacture.

Dated 30th November, 1857.

2970. J. Nichols, Pendleton, near Manchester—Sizing yarns or threads.
2972. T. Kaye, Grange-moor, Whitley-lower, near Dewsbury—Looms for weaving.
2974. P. A. Montel, Paris.—Motive power.
2976. D. K. Clark, 11, Adam-street, Adelphi.—Combustion of fuel without smoke, and communication of heat.
2978. J. Howard, Bedford—Ploughs.
2979. A. V. Newton, 66, Chancery-lane—Cleaning carpets and other fabrics.
2980. J. B. Couy, Nantes—Manure, and for the disinfection of animal and vegetable matters.
2981. S. Solomon, Wood-street, Spitalfields – Umbrella, parasol, and walking sticks or canes.

Dated 1st December, 1857.

2983. F. G. Spray, London—Gunpowder.
2984. R. Hipkiss and W. Olsen, Birmingham—Lubricating shafts and axles.
2985. D. Lane, Cork—Lighting, regulating, and extinguishing street and other gas lamps by means of electricity.
2986. T. J. Thompson, Greenwood-park, Newry, Down, Ireland—Lighting railway trains with gas.

Dated 2nd December, 1857.

2987. E. C. Shepard, Jermyn street—Magneto-electric machines.
2988. J. Summers, Stalybridge, Cheshire, and D. Wormald, Dukinfield — Clog irons, and heels and tips for boots.
2989. J. Eccles, Blackburn—Coloring or ornamenting bricks, tiles, pipes, and other articles made of plastic earths.
2990. J. Hetherington, Birmingham—Bowls of castors for furniture.
2991. W. Bird and R. Ashton, Blackburn, and T. Bird, Manchester—Looms and pickers for looms.
2992. W. Thomson, Dalkeith-park-gardens, Midlothian, N.B.—Propelling ships or vessels.
2993. C. J. M. Moireau, 23, Avenue de la Porte Maillot, Passy, near Paris—A composition for bees' wax.
2994. J. Fowler, jun., 28, Cornhill, and W. Worby, Ipswich —Ploughing, tilling, or cultivating land.
2995. J. Francis, United States, and C. Manby, Great George-street, Westminster — Waggons and other vehicles, applicable to the transport of troops and military and other stores on land and water.
2996. A. Parkes and H. Parkes, Birmingham—Sheathing metals.
2997. J. Livesey, New Lenton, Nottingham—Pile fabrics, and machinery employed therein.

Dated 3rd December, 1857.

2998. L. F. E. Ciceri, 38, Rue Pigale, Paris—White as a basis of color.
2999. G. T. Bousfield, Loughboro'-park, Brixton—Collapsible boats.
3000. R. Hazard, Thanet-place, Temple-bar—Self-acting reclining chair or couch.
3001. E. Slack, Glasgow—Use of wheat and other grains, and amylaceous vegetable substances.
3002. J. Reeve, 46, Rutland gate—Propelling vessels.
3003. C. Henwood, Oxford—Galvanic battery suitable for medical purposes.
3004. W. Parsons and J. Attree, Brighton—Cock or tap and flushing apparatus.

Dated 4th December, 1857.

3005. J. Buchanan, Liverpool — Smoke-consuming apparatus, applicable to boiler and other furnaces.
3006. A. Ripley, St. Helen's, Lancashire—Mills for grinding myrabolams, valonia, bark, and other similar substances.
3007. J. Hamilton, Halifax—"Strained wire fencing" for dividing fields and parks.
3008. H. Deacon, Woodend Chemical Works, Widnes Dock, near Warrington—Soda and potash.
3009. J. Rubery, Birmingham—Umbrellas and parasols, and new condition of materials.
3010. J. de Helle, and A. Viscount de Waresquiel, Paris—Railway rolling stock.
3011. S. H. Sewers, Curry Rivel, Somerset—Powder for dusting turnips, and machinery for distributing the same.
3012. J. Grizard, Nevers, France—Winding up and setting watches.
3013. W. Standring, Bury-road, Rochdale—Throstle and mule spring for the under clearers of spinning machines.
3014. A. Morton and J. Howden, Glasgow—Motive power.

Dated 5th December, 1857.

3015. S. J. Count Ostrorog, Paris—A wind musical instrument.
3016. W. Caldwell, Liverpool—Fluid meter, may be used as a motive-power engine.
3017. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Lucifer matches.
3018. W. Mercer, W. Bodden, and W. Higginson, Oldham—Machinery for slubbing and roving cotton.
3019. T. Sidebottom Adshead, and A. Holden, North-end, near Stalybridge, Cheshire—A self-acting combination of machinery for the grinding of carding engine rollers.
3020. W. T. Henley, 46, St. John-street-road—Ropes and cables for telegraphic purposes.
3021. J. Brinton and J. Crabtree, Kidderminster- Preparation of weft yarn to be used in the manufacture of carpets and other pile fabrics.
3022. J. Sinclair, Hill-street—Cutting or dividing stone and marble.
3024. W. E. Newton, 66, Chancery-lane—Apparatus for laying submarine telegraph cables.

Dated 7th December, 1857.

3025. D. Hiley, P. Hiley, W. Hargreaves, and E. Haley, Bradford—Weaving worsted, cotton, silk, woollen, and other fibrous substances.
3028. J. Stiff, London Pottery, High-st., Lambeth—Drain pipes.
3029. G. C. Greenwell and W. Selby, Radstock—Washing coals and other minerals, separating from other substances.
3030. J. Harris, Hanwell, Middlesex—Signalling.
3031. R. Reeves and J. Reeves, Bratton, near Westbury, Wilts—Implements for depositing seed and manure.

Dated 8th December, 1857.

3032. G. Holcroft, Manchester, and G. Denholm, Wigan—Steam engines.
3033. B. Shaw, Wellington, Salop—Construction of windows.
3034. H. Pershouse, Birmingham—Stereoscopes.
3035. E. Outram, Leeds—Steam regulator.
3036. C. Nightingale, Wardour-st., Soho—Feeding hair and fibres intended to be spun or twisted.
3037. H. Dolman, Nelson-st., Greenwich—Stand for "cheval" and other "dressing" glasses.
3039. W. E. Newton, 66, Chancery-la.—Obtaining motive power.
3040. W. Rowan, Belfast—Spinning flax and other fibrous material, in preparing the same for weaving.
3041. R. A. Brooman, 166, Fleet-st.—Cocks and valves for regulating the flow of fluids.
3042. T. W. Willett, 89, Chancery-la.—Gunpowder.

Dated 9th December, 1857.

3043. C. De Bergue, 9, Dowgate-hill—Blowing or feeding air into furnaces or other fire-places.
3044. S. Clark, 55, Albany-st., Regent's-park—Wicks.
3045. C. Westendarp, jun., Mincing-lane—Material as a substitute for ivory, which he proposes calling "artificial ivory."
3046. J. Smith, Walsall, Staffordshire—Securing rails.
3047. J. Haddon, Glover-street Works, Birmingham—Wood screws, a portion applicable in the manufacturing of certain descriptions of nails.
3048. W. Riddle, 4, Stonefield-ter., Liverpool-rd.—Steam engines.

Dated 10th December, 1857.

3049. J. Hoddell, Northampton-sq., Clerkenwell—Watches.
3050. R. R. Cox, Kentish-town—Fire lighters, and apparatus or stoves for burning the same.
3051. G. Ther-Katz, Paris—Hackney-coach and other public carriages.
3052. I. A. Best, St. Paul's-sq., Birmingham—Printing types.
3053. S. Biggin and J. Biggin, Sheffield—Handles of tea and coffee pots.

Dated 11th December, 1857.

3054. J. Chadwick, Manchester, and A. Elliott, West Houghton, Lancashire—Spinning, doubling, and throwing silk.
3055. J. Tanton, Frederick-st., Caledonian-rd.—Shepherd's crooks.
3056. J. Gedge, 4, Wellington-street South, Strand—Process of rectifying liquids.
3057. J. Stather, Hull—Surfaces in imitation of wood for printing from.
3058. W. Denne, County Lunatic Asylum, Bedford—Lifting patients off beds and other surfaces used for reclining upon.
3059. N. R. Hall, Northfleet—Registering the phases and age of the moon.
3060. J. Roberts, St. Leonard's Iron Works, Poplar, and M. Beale, Surrey-st., Strand—Obtaining and applying motive power, applicable chiefly to the working of ships' pumps.

Dated 12th December, 1857.

3061. J. Parker, 4, Grove-ter., Grove-rd., Forest-vale, Sydenham—Steam power for the movement of vessels or other bodies floating on or suspended in water, air, or other fluid, and for moving machinery, and propelling solid bodies on land.
3062. F. Walton, Haughton Dale Mills, near Manchester—Rollers used in machinery for preparing and spinning fibrous materials, and for other purposes where elastic pressure is required, also in the machinery employed in the manufacture of the said rollers.
3063. F. Puls, Haverstock-hill—Combination of mineral substances for the production of artificial stone.
3064. W. Uren, Redruth, Cornwall—Machinery for cleaning and dressing minerals.
3065. J. de Normann, Naples, and W. T. Henley, St. John-street-rd., London—Preventing the overlapping of chains or ropes when used on drums or shafts, which improvements can be applied to the laying of telegraphic cables.
3066. C. Cowper, 20, Southampton-buildings, Chancery-la. —Photography.
3067. J. M. Préaud, 53, Chancery-la.—Engine with rotary piston.
3068. H. D. P. Cunningham, Bury—Reefing and furling sails.

Dated 14th December, 1857.

3069. J. Oldfield, Haughton, Lancashire — Cutting and separating fur, or hair, or wool, from hides or skins, also applicable to cutting vegetable or fibrous materials.
3070. H. Bunting, Colchester—Obtaining and applying motive power.
3071. J. P. Brignon, 39, Rue de l'Echiquier, Paris—Forging.
3072. W. Little, Queen's-rd., Regent's-park—Lamps.
3073. J. Parker, Liverpool—Bedsteads.
3074. A. Baird, Finchett-house, near Liverpool—Regulating the supply of water and other fluids for domestic and other purposes.

Dated 15th December, 1857.

3075. J. Hogg, jun., 18, St. Andrew-sq., Edinburgh—"Copying-paper."
3076. W. Smith, 10, Salisbury-st., Adelphi—Chromotypographical printing presses.
3077. E. Breffit, 61, King William-st., City—Glass bottles.
3078. J. Bradley, Huddersfield—Ovens applicable for baking bread and pastry, roasting or cooking meats.
3079. J. Chadwick, Castleton Print Works, near Rochdale—Rollers or cylinders for printing or staining the surfaces of woven fabrics, yarns, and paper.
3080. E. Turner, Bradford, Yorkshire, and J. C. Pearce, Bowling, near Bradford—Railway wheels.
3081. F. Bedwell, Bathwick-hill, Bath—Communicating between the passengers and guard, and the guard and engine-driver, upon railways.
3082. G. T. Bousfield, Loughborough-park, Brixton—Cast steel.
3083. W. Galloway and J. Galloway, Manchester—Hydraulic presses.

3084. T. Howard, the King and Queen's Iron Works, Rotherhithe—Rolling iron bars used in the construction of suspension bridges.
3085. G. A. Everitt, Birmingham—Manufacture of tubes or cylinders of copper or alloys of copper.

Dated 16th December, 1857.

3086. J. F. Seeley, Everett-street, Brunswick-square—Cutting out materials used in the manufacture of boots and shoes.
3087. J. G. Gibson, Cheetham, Manchester, and S. Berrisford, Stockport, Cheshire—Looms for weaving, parts of which improvements are applicable to lubricating bearings generally.
3088. J. Thornton, Nottingham—Apparatus for manufacture of carpets and other cut pile fabrics.
3089. J. Marland, Fernlee Vale, near Upper Mill, Saddleworth, Yorkshire—Facilitating the placing of cop tubes on to spindles.
3090. M. Semple, Stonehouse, Devon—Preserving meat, fruit, vegetables, and other edible substances and fluids.
3091. E. Hills, Warsash, Titchfield, Southampton—White lead, and in the working up of the waste materials.
3092. H. Gregory, Manchester — Making "lozenges," or other similar articles.
3093. J. H. Dickson, Stanley-ter., Rotherhithe—Scutching and hackling flax, hemp, and other similar fibrous materials.
3094. Dr. J. J. Cregeen, Plough-road, Rotherhithe—Treatment of India and China grass, pine apple, hemp, flax, and other similar fibrous materials.

Dated 17th December, 1857.

3095. M. J. Turner and M. W. Turner, Woodcote, Surrey—Improvement of conduit pipes and tubes for sewers, drains, conduits, and gas.
3096. F. M. Blyth, Norwich—Apparatus for cutting and pulping turnips.
3097. W. Blizzard, 14, Victoria-terrace, Notting-hill—Improvements in the treatment of india rubber by a new process for the manufacture of a crystalline and colourless varnish for waterproofing all kinds of textile fabrics and papers, without smell and without in any degree altering their appearance, and for making divers varnishes and paints.
3098. J. J. Davis, Percival-street, Clerkenwell—Presses for printing, or endorsing and embossing.
3099. M. Mason, Dukinfield, Chester, and T. Markland, Newton, near Hyde—Apparatus for printing.
3101. E. Highton, Regent's-park—Electric telegraphs.
3102. H. Johnson, Crutchedfriars—Apparatus for drawing geometric curves.
3104. W. Woofe, Tetbury, Gloucestershire—Ploughs.
3105. J. H. Johnson, 47, Lincoln's-inn-fields—Lubricating the journals of shafts and spindles.
3106. J. H. Johnson, 47, Lincoln's-inn-fields — Hulling cotton and other oleaginous seeds, applicable also to the hulling of cereals.

Dated 18th December, 1857.

3107. J. B. Howell and J. Shortridge, Sheffield—Mode of rolling steel for springs.
3108. J. H. Taylor and R. T. Barrett, Victoria Dock-road, Essex — Prevention of smoke, and for effecting a better consumption of fuel in steam-boiler furnaces.
3109. D. Bowlas, Reddish, Lancashire—Apparatus for preparing and spinning cotton and other fibrous substances.
3110. T. C. Wilkinson, Ashford, Kent—Pump-valves.
3113. J. M. Napier, York-road, Lambeth — Letter-press printing machines.
3114. R. Oxland, Plymouth — Manufacture of alloys or compounds containing metallic tungsten.

Dated 19th December, 1857.

3115. T. Newey, J. Corbett and W. H. Parkes, Birmingham —Improved method of treating or coating steel pens and pen-holders, to prevent the oxidation of the same, which method of treating or coating may also be applied to other articles of iron and steel.
3116. A. Lees and J. Clegg, Soho Ironworks, Greenacres-moor, near Oldham, Lancaster—Looms for weaving.
3118. R. Furnival, Manchester—Apparatus for cutting paper, cardboard, and similar articles.
3119. W. Walker, Leeds—Heating and drying.
3120. R. A. Brooman, 166, Fleet-street—Signalling, to prevent collisions between trains upon railways.
3121. R. A. Brooman, 166, Fleet-street—Lime kilns, and in apparatuses employed for working the same.
3122. J. Bartlett, Bristol—Weighing machines.
3123. T. Coles, Bristol—Chaff cutters.
3124. W. Bough, 1, Jewin-crescent, Cripplegate—Lamps and wicks for burning resin and other oils and fluids, parts of which improvements are applicable to Argand gas burners.
3125. R. Mushet, Coleford, Gloucester—Manufacture of iron.

Dated 21st December, 1857.

3128. J. Hamilton, Liverpool—Shipbuilding.
3129. W. J. Kendall, Norwich—Safety signal for railways.
3130. R. Rennie, Netherwood, Dumbarton — Self-acting trap-doors for mines.
3131. F. Taylor, Romsey—Closets or privies.
3132. G. T. Bousfield, Loughborough-park, Brixton—Machinery used in the manufacture of springs, and in the application of springs to carriages.
3133. W. H. Myers, 202, Whitechapel-road—An improved coffee pot, made of metal or earthenware, to contain coffee and milk or cream separately, the same being used as a chocolate pot, the same invention being applicable to teapots for the same purposes, made either in metal or earthenware, the same invention being applicable to table urns, and the same invention being applicable to jugs, made either in earthenware, or glass, or metal, to contain spirits and water or other liquids in different compartments.
3134. J. Tatlow and H. Hodgkinson, Wirksworth, Derby - Railway-breaks, and apparatuses for connecting shafts or rods for working breaks and signals.
3135. R. A. Brooman, 166, Fleet-st.—Breech-loading fire arms.
3136. W. Basford, No. 15, Lowther-cottages, Liverpool-road, Islington—Gas, and retorts and other apparatus to be used therein.
3137. A. René le Mire de Normandy, Judd-st., Brunswick-sq.—Distilling sea water on board ships and vessels.
3138. R. F. Sturges, Birmingham—Manufacture of rollers, or cylinders for printing fabrics.

Dated 22nd December, 1857.

3139. A. C. Kennard, Falkirk Iron Works, Stirling, N.B.—Trussed iron bridges.
3140. S. Rodgett and D. Rodgett, Blackburn—Coupling and uncoupling railway, tramway, and other carriages, waggons, lorries, trucks, and other vehicles.
3141. J. H. Johnson, 47, Lincoln's-inn-field—signal apparatus to be attached to common road carriages.
3142. M. Landou, 25, Pudding-lane—Cooking utensils.
3143. O. Greenhalgh, and R. Hutchinson, Horwich, Lancashire—Apparatus for stirring and mixing colours for calico printing and other purposes.
3144. E. Maw, Doncaster Iron-works, Yorkshire—Ornamenting and strengthening metal tubes and rods with wood, applicable in the manufacture of bedsteads and other articles of furniture and framings, and also in the manufacture of the joints or connections of the posts and framings of bedsteads, and other articles of furniture and frames.
3145. G. Bridge, Bollington, near Macclesfield, and J. Hamer, Longsight, near Manchester—Manufacture for converting woven silken fabrics, or silk waste into a fibrous material fit for being spun into yarn or thread, or for being mixed with silk, woollen, cotton, or any other material to be spun into yarn or thread, and of improvements in machinery to be employed in such process or manufacture.

Dated 23rd December, 1857.

3146. D. J. Crossley, Hebden-bridge, Yorkshire—Manufacture of certain textile fabrics, called Pellones, and used for saddle covers, and in the machinery or apparatus employed therein, which improvements are also applicable for weaving other fabrics.
3147. T. Landi, 16, Rue de Boulevard, Batignoles, Paris, and C. Falconieri, 20, Charles-st., Middlesex Hospital, London—Laying subaqueous electrical cables for telegraphic communication.
3149. C. N. Nixon, Ramsgate—Attaching, fitting, and securing the rudders of ships, barges, boats, and every other description of sailing or steam vessel.
3150. A. P. Kynaston, R.N., Plymouth—Slip or disengaging hook.
3151. J. Moss, T. Gamble, and J. Gamble, Sheffield—Manufacture of cast-steel hoops and cylinders.
3152. J. Murray, Whitehall-place—Propelling ships and vessels.
3153. C. Norton, 3, Lancaster-pl., Camden-st., Camden-town —Carriage door shields to prevent accidents arising from the shutting of railway or other carriage doors, also applicable to nursery doors, or any other doors, where children may have access, or where safety from accident may be an object.
3154. A. W. Williamson, 16, Provost-road, Haverstock-hill — Treating scammony root and commercial scammony, to obtain the active principle therefrom.

Dated 24th December, 1857.

3155. G. White, 5, Lawrence Pountney-lane, Cannon-st.—A semi-melodion, or instrument for demonstrating musical writing.
3156. C. Reeves, Birmingham—Revolving fire-arms.
3157. S. H. Adderley, of Birmingham—Manufacture and ornamentation of pencil cases, pen-holders, reserves or cases for leads, needle cases, and ink-holders, and other tubular cases.
3158. T. Playle, Chatham—Two-wheeled carriages.
3159. G. Croft, Leeds-st., Keighley, and S. D. Steel, Greengate Mills, Keighly, Yorkshire — Machinery for combing and preparing wool and other fibrous substances.
3161. G. Burley, King's-cross-road, near Halifax—Apparatus for cutting the pile of fustians and other pile fabrics.
3162. H. C. F. Wilson and T. Green, Dunston—Apparatus for making rivets.
3163. H. C. F. Wilson and T. Green, Dunston—Machinery for making rivets.
3164. B. Burleigh, 26, Great George-st., Westminster, and F. L. Danchell, 452, Oxford-st.—Manufacture of vessels, plates, or utensils used for domestic, sanitary electric, and manufacturing purposes.

Dated 26th December, 1857.

3165. A. Chaplin, Glasgow—Steam engines, and combustion of fuel.
3166. A. R. Saraiva, Nottingham-st., Marylebone—Candlestick or holder.
3167. C. F. Parsons, 1, Duke-st., Long-alley, Finsbury—Cleansing and reburning animal charcoal.

Dated 28th December, 1857.

3168. A. Bruce, Manchester—Watches and time-pieces.
3169. J. Barling, Halifax—An improved paddle for propulsion on water.
3170. J. H. Johnson, 47, Lincoln's-inn fields—Treatment and preservation of skins, furs, wool, and textile fabrics, and in the machinery or apparatus employed therein.
3171. H. Deacon, Widnes—Purifying alkaline lees.
3172. J. Boydell, 65, Gloucester-crescent, Camden-town — Carriages propelled by steam or other power.
3173. J. Wadsworth, Hazelgrove, near Stockport—Production and management of artificial light, and in apparatus applicable thereto.
3176. J. T. Griffiths, New Basford, Nottingham—Manufacture and ornamenting of lace.
3177. I. Holden, St. Denis, near Paris—Preparing and combing wool and other fibres.

Dated 29th December, 1857.

3178. T. Spencer, 192, Euston-road—Illuminating or lighting gas.
3179. H. Thompson, Liverpool—Use of a certain substance as a substitute for glue, paste, cement, varnish, and other similar compounds.
3180. J. Hargreaves and J. Hargreaves, Liverpool—Winding up watches which have not fusees or chains.
3181. A. Parkes, Birmingham—Joining or uniting metals.
3182. V. Mourot, 43, Rue de Paradis Poissonnière, Paris—Furnaces for heating kilns and ovens used in the manufacture of pottery and earthenware, part of which improvements are also applicable to furnaces generally.
3183. E. Gomez and W. Mills, New York, U.S.—Composition for trains or safety fusees, and similar purposes.

Dated 30th December, 1857.

3185. F. O. Ward, 12, Cork-street, Burlington-gardens — Liberating or producing potash or soda, or both (as the case may be), from natural alcaliferous silicates, the residuum of the process being available as a material for manure, puzzolano, or hydraulic cement.
3186. W. H. Tooth, 9, Sumner-st., Southwark—Furnaces.
3187. F. Palling, 134, Princes-road, Surrey—Construction of candles, lamps, and candle-lamps, without wicks.
3188. T. Booth, Manchester—Treatment of certain vegetable matters, and in the application of the same to sizeing, stiffening, dressing, and finishing textile materials, and which is also applicable to thickening colours for printing.
3189. J. D. Morrison, Edinburgh—Effecting surgical and medical operations by the agency of artificially induced anæsthesia.
3190. J. O'Neill, Liverpool—Apparatus for communicating betwixt the guard or passengers and the engine-driver on railway trains.
3191. A. V. Newton, 66, Chancery-lane—Machinery for cutting corks and bungs.
3193. R. Harmer, Union-st., Spitalfields—Cigarettes.

Dated 31st December, 1857.

3194. C. Buhring, 91, Pratt-st., Camden-town—Combination of carbonized and carbonizable with other materials, and the manufacture of such compounds into various useful articles.

INVENTIONS WITH COMPLETE SPECIFICATION FILED.

3100. J. E. Barton, Kidderminster—Winding worsted on to the creel bobbins of carpet looms.—17th December, 1857.
3103. J. Broad, 149 and 150, Drury-la.—The construction of a pressure or fountain lamp, to burn with safety from ignition in the overflow, and from explosion, all bituminous, carbonaceous, and resinous oils, spirits, and naphthas, or admixtures thereof, also the products of Rangoon earth oil, or petroleum, also to adapt all pressure and fountain lamps to burn these substances which are found to ignite in the overflow and cause explosion, &c., in all such lamps as a present constructed.—17th December, 1857.
3111. S. Darling, State of Maine, U.S.—Pencil sharpener.—18th December, 1857.
3112. C. Winslow, State of Massachusetts, U.S.—"Elastic gore cloth."—18th December, 1857.
3175. J. Cottrill, Studley, Warwick—Certain descriptions of needles.
2. J. Murphy, Newport, Monmouthshire—Wheels used on railways.—January 1, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4036. Dec. 10. J. J. Welch and J. S. Margetson, Cheapside, "The Tourists' or Expanding Collar."
4037. „ 28. G. Dawler, Birmingham, "Anti-corrosive Inkstand."
4038. „ 29. D. Prosser, Harescomb, Gloucestershire, "Feeding Trough for Pigs and other Animals."
4039. „ 29. Dent, Allcroft, and Co., Wood-st., Cheapside, E.C., "The London Shirt Front."
4040. Jan. 4. J. Cartwright, Shrewsbury, "Expanding bar for Chain Harrows."
4041 „ 5. J. Faulkner, 62, St. Martin's-le-Grand, "A Paper File."
4042. „ 6. W. J. Salmons, 100, Fenchurch-street, "Salmons' Calosynthetic Stereoscope."
4043. „ John Gordon, 3, Railway-place, Fenchurch-street, "Ballast or Shovel Hoe."

LAURIE'S IMPROVED LAYING MACHINE.

FIG. 3, FRONT PLATE.

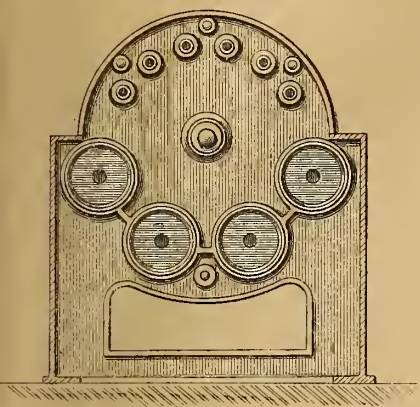


FIG. 1, SIDE ELEVATION.

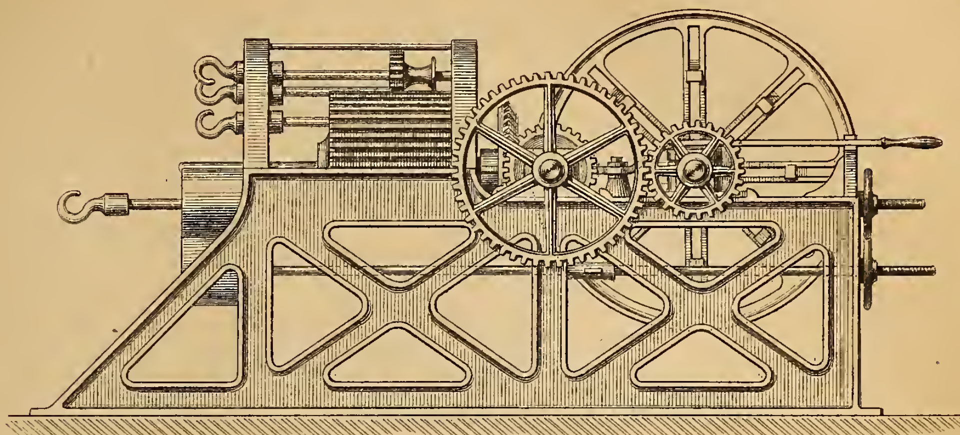


FIG. 4, MIDDLE PLATE.

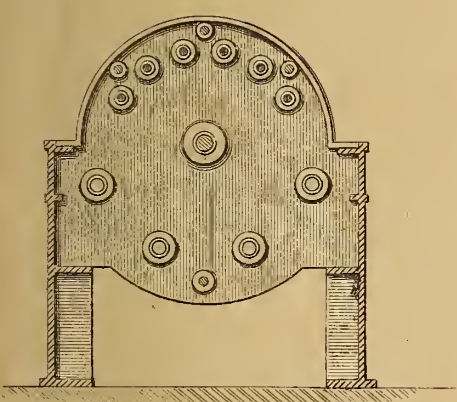


FIG. 2, PLAN.

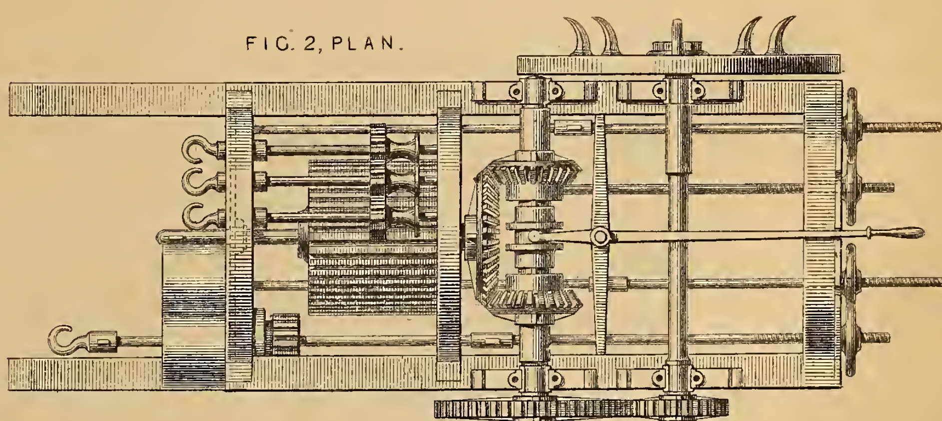


FIG. 5, BACK PLATE.

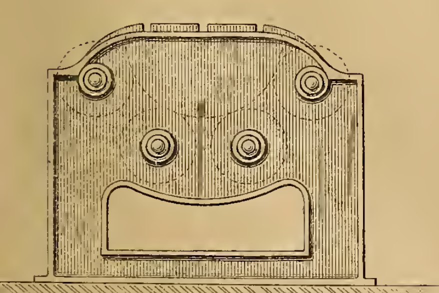
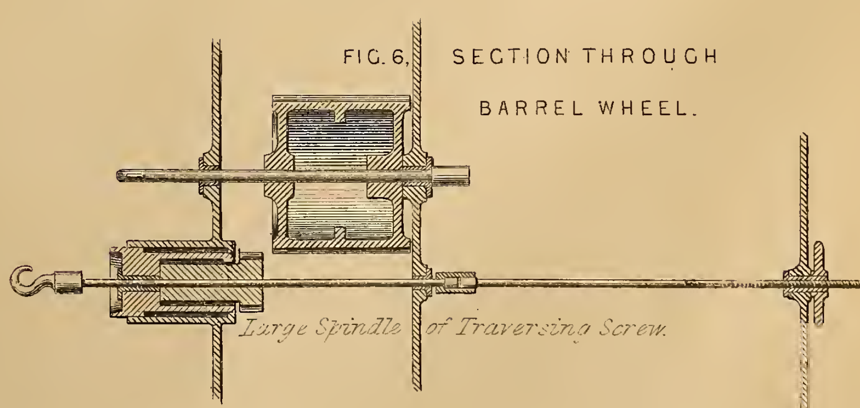
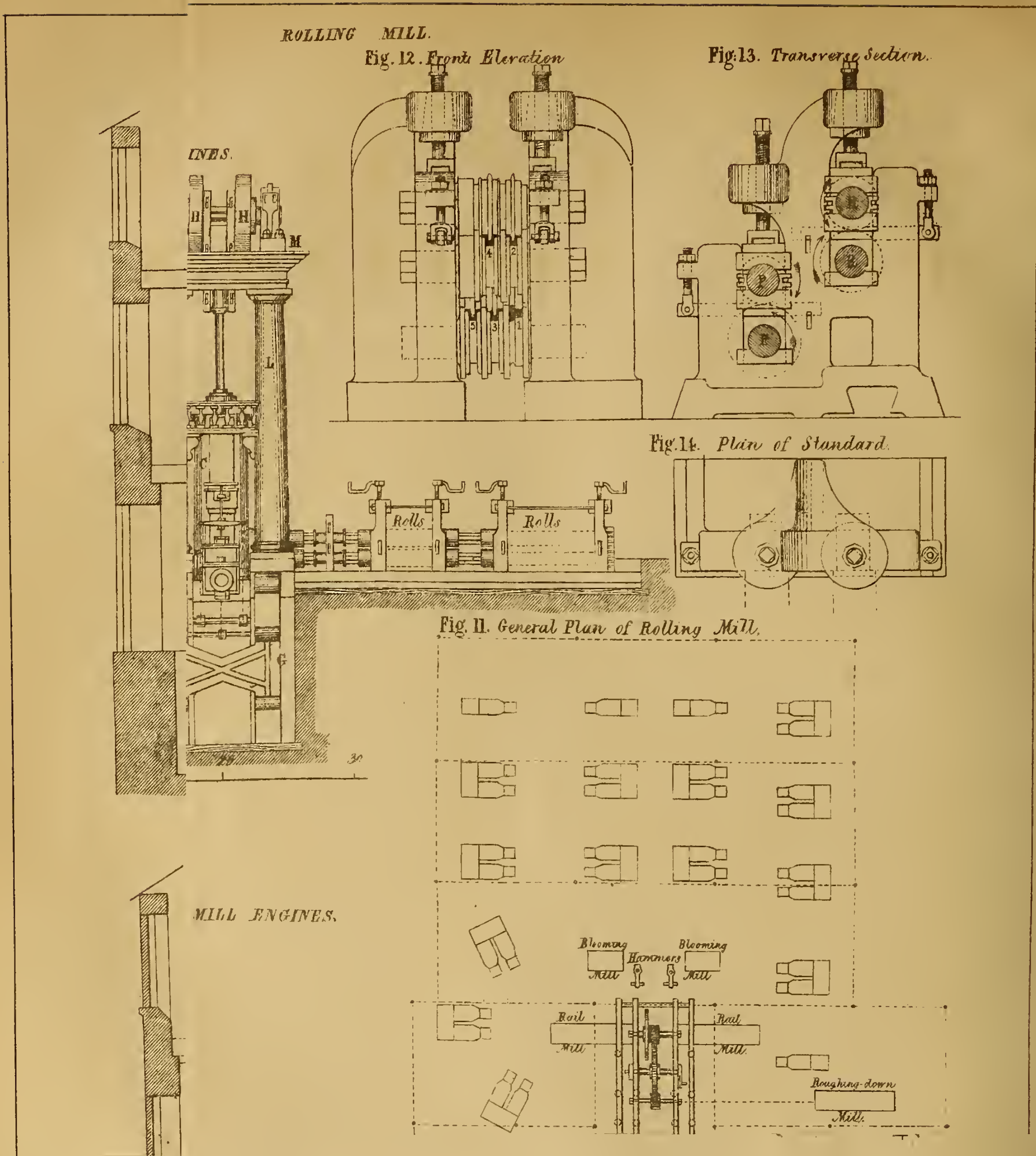


FIG. 6, SECTION THROUGH BARREL WHEEL.




ROLLING MILL.
Fig. 12. Front Elevation
Fig. 13. Transverse Section.
INES.
Rolls
Rolls
Fig. 14. Plan of Standard.
Fig. 11. General Plan of Rolling Mill.
MILL ENGINES.
Blooming Mill
Hammers
Blooming Mill
Rail Mill
Rail Mill
Roughing-down Mill.

THE ARTIZAN.

No. CLXXXII.—Vol. XVI.—MARCH 1st, 1858.

LAURIE'S IMPROVED LAYING MACHINE.

(Illustrated by Plate No. cxviii.)

We have upon former occasions presented to our subscribers illustrations of hemp and flax-spinning machinery, such as have been more particularly employed for producing threads and yarns for the manufacture of ropes, lines, &c.; and, with a view of making the series connected with the manufacture of ropes, &c., as complete as possible, we have selected, from a large number of plans of rope-making machinery which have come under our notice during a long practical acquaintance with this branch of industry, Laurie's Laying Machine, as the most perfect example of the machinery employed for this purpose in the old-fashioned long-rope-walk system of rope making, which system of ropemaking is still extensively practised throughout the world, notwithstanding the rapid strides which the systems of Huddart and other more recently invented vertical and horizontal machines have made within the last few years.

As our space in the present Number will not permit of our giving a description of the machine illustrated by Plate No. cxviii., we must defer doing so until next month.

THE NEW GRAVING DOCK, DUBLIN.

At no harbour or port, perhaps, in the three kingdoms, has the necessity for proper accommodation for the repairs of shipping been more severely felt than at Dublin; and the consequence has been, that vast sums of money are being yearly spent out of the port in the repairs of vessels. This fact is the more singular when we reflect on the many advantages the harbour possesses, in depth of water, good foundation, &c.

Before the year 1796 there were no graving-docks in Dublin, but in that year three were erected, in connection with a large basin, by the Grand Canal Company; and they are, even to the present time, the only graving-dock accommodation.

The Corporation for Preserving and Improving the Port, some thirty years ago, bestirred themselves in this matter, and had two patent slips erected, on Morton's principle—one for vessels of 400 tons and under, and a second for vessels of 800 tons, builders' measurement; the smaller slip being almost always occupied with their own barges and mud floats, the larger they lend for the repairs of vessels at a trifling charge per ton per day, with something extra for launching and hauling up.

The want of further accommodation being for many years glariugly apparent, several designs were submitted to the Chamber of Commerce and Ballast Board; and from those the plans of their own Engineer, or Inspector of Works, was selected, as being the most suited to the necessities and state of the harbour; and, in 1850, the requisite boreings and examination of the site was proceeded with.

The design contemplated a floating-basin of about 38 acres in extent, two graving-docks, of the respective lengths of 400 and 300 ft., a graving-slip, and large and commodious building-yards, quays, &c., &c. In 1851 operations were commenced, by forming a vast embankment with the deposit dredged from the channel of the harbour, and this work progressed so rapidly, that in less than a year the working plans were in the hands of the engineering draftsman, and the Corporation was in a position to advertise for contractors.

After the different tenders had received the proper attention and consideration that such matters require, Mr. Dargan was declared the contractor, and, as is unhappily not unusual in such cases, a great deal of jealously was the result; one firm going the length of publishing a protest, which was very industriously circulated amongst the building trades and corporate bodies of Ireland.

The Ballast Board, however, were not to be moved from "the even tenor of their way" by such "weak inventions;" and before many more months elapsed, large quantities of "plant" were daily being brought to the ground, and sheds, engine-houses, and colossal chimneys began to spring up on the great bank of newly-recovered alluvium.

Various descriptions of pile-driving engines were erected, amongst which Nasmyth's stood prominent; and pumps, with their attendant steam-engines, strewed the ground on all sides. Then might be seen men laying down a railway, surrounding the vast hollow in which the dock was to be erected; and on these rails a locomotive and its tender was shortly to be seen simmering away whilst waiting patiently till called on to move the ponderous beams of timber and blocks of granite that were daily coming to the works. Dublin has rarely seen a work of such activity, excepting the building of its Exhibition in 1853. Upwars of 2,000 Memel piles, averaging 30 ft. in length, and containing somewhere about 1,500 tons of timber, were all shaped and fitted with wrought, and in some cases cast, iron shoes, and hooped on the head with best wrought-iron rings.

To secure the cross bearers and sleepers of the timber platform (on which the stone work was intended to rest) to the piles, large wood screws were required, 5 ft. in length; and these having, as a matter of course, to be cut with a taper core, Mr. Dargan had erected on the ground some very ingenious screwing lathes for this purpose.

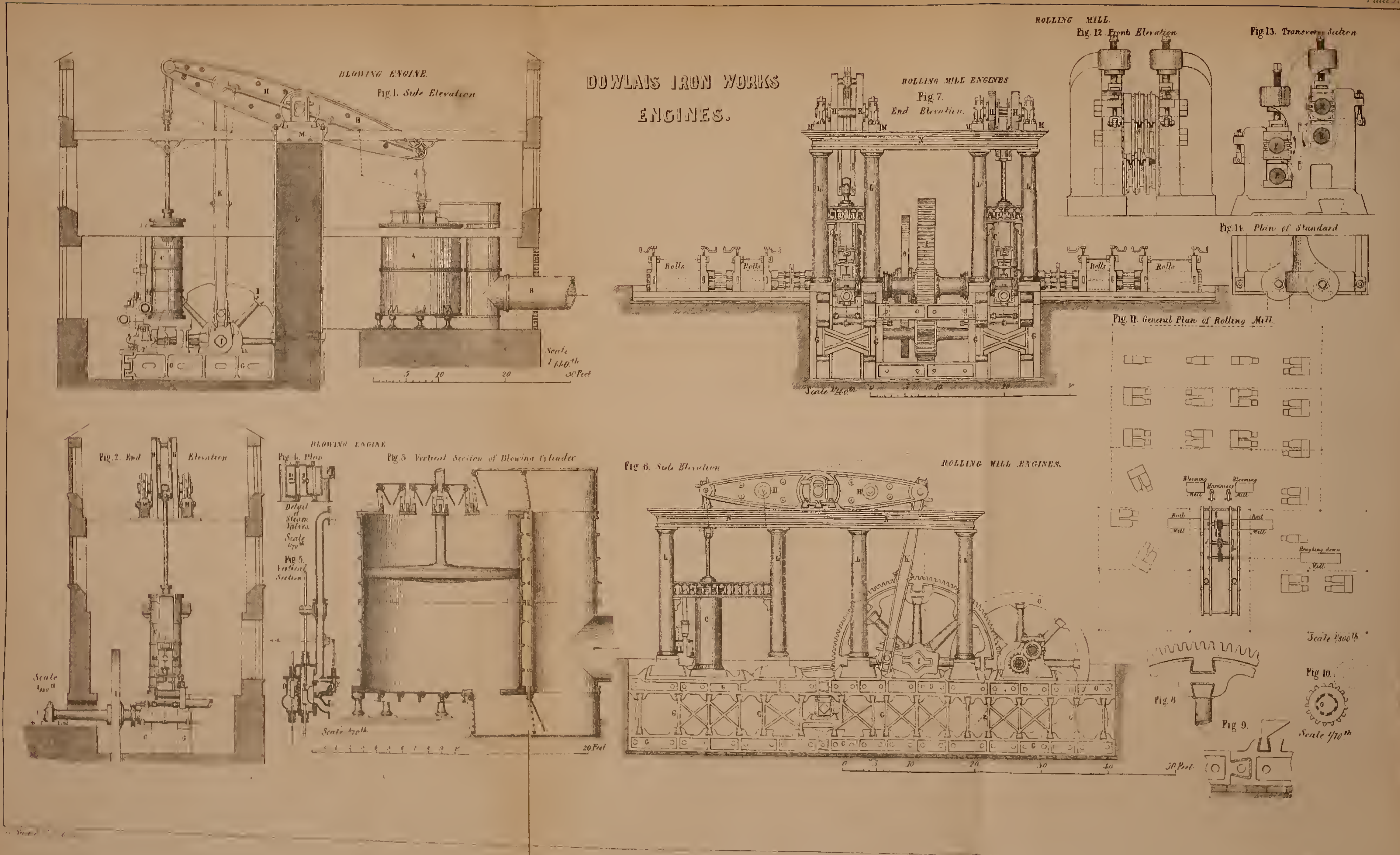
Many opinions as to the best method of driving the piles into such a stiff bottom were elicited, and different foremen of the contractors tried different plans, which only resulted in delaying the operations for a lengthened period. The works were at last, however, given by the contractor into the hands of a Mr. Browne, who at once caused the Nasmyth engines to be set to work, and the piling went on rapidly. The large engine which had hitherto been in use at the works of the great Cork Tunnel, was erected; two other powerful horizontal engines were placed at the head of the dock space, and a large beam, and a direct-acting engine, were brought to bear on the lower or south end. The pumps used were three pair of lift, and two centrifugal.

There was no coffer-dam used (in the general acceptation of the term), but the south end of the dock was closed in by a great bank of earth, deposited there by the floats of the Ballast Board.

The piles having been driven to the requisite depth, which, we have been informed, averaged 30 ft., were cut off to the proper height, and the ground all brought to a level 1 ft. below that height. On this was laid the concrete, formed of small stones or gravel and Portland cement, in proportions which we will describe when we enter into the details of the work. This concrete was brought up to a level with the top of the cross bearers and sleepers, and having been finished off, was left for a short time to set, when the planking commenced, and was proceeded with and completed in a very short time. The vast timber floor at this time presented a novel and rather striking appearance, the dimensions being nearly 500 ft. by 100 ft.

We must not, however, forget to mention how the long 5-ft. wood screws were driven home: the holes were bored with shell-augers to the depth required, and the screw then introduced—a circular countersinking being formed for the head, so that the top of the head might range flush with the upper skin of the sleepers, and not interfere with the planking. A small capstan of wrought and cast iron, its centre post being a polygonal tube, was put down over the screw, the bottom resting on the sleeper; and when in this position, it was sufficiently high to catch the top of the screw: it was then turned by four men pushing the bars, when, as it carried the screw round, it was also free to travel down the tube. The entering and driving home of a screw in this manner only occupied a few minutes.

At this stage of the proceeding the erection of the great gantries, or


DOWLAIS IRON WORKS
ENGINES.
BLOWING ENGINE.
Fig 1. Side Elevation
Scale 1/140th
Fig. 2. End Elevation
Scale 1/140th
BLOWING ENGINE
Fig. 4. Plan
Detail of Steam Valves.
Scale 1/70th
Fig 5. Vertical Section
Fig 3. Vertical Section of Blowing Cylinder
Scale 1/70th
20 Feet
ROLLING MILL ENGINES
Fig 7.
End Elevation.
Rolls
Rolls
Rolls
Rolls
Scale 1/140th
Fig 6. Side Elevation
ROLLING MILL ENGINES.
50 Feet
ROLLING MILL.
Fig. 12. Front Elevation
Fig. 13. Transverse Section.
Fig. 14. Plan of Standard
Fig. 11. General Plan of Rolling Mill.
Roughing down Mill
Scale 1/800th
Fig 8
Fig 9.
Fig 10.
Scale 1/70th

travelling cranes, commenced; three of these in particular were looked upon as being remarkably well constructed, and had been engaged with great success in the erection of the Boyne Viaduct. They were fitted with ribbons of wrought iron, instead of chains; and although not at all so safe as chains, where any twist was likely to occur, they were considered much smoother in working, and large stones could be set by them with greater facility.

The Dock had been so far completed that, in July, 1857, the erection of the gates was commenced, and finished in about ten weeks. Of these, and the Graving Dock, we propose, from time to time, giving detailed drawings on a comprehensive scale. For the present our space will not permit us to say more on the subject; but we hope shortly to have an opportunity of again referring to the New Dublin Graving Dock—a work which reflects the greatest credit on the designer, George Halpin, Esq., and all concerned in the undertaking.

ON CALCULATING THE RESISTANCE OF STEAM-VESSELS.

By Dr. Eckhardt, Privy Councillor, Darmstadt.

Having read with great interest the various discussions on the arithmetic of naval architecture, &c., which have appeared in your excellent Journal, The Artizan, I have been astonished at the great difference of opinion expressed by the different writers on this important subject. The difficulty consists in a general determination of the resistance of water against any surface, so as to make them correspond with actual observations; but in this particular case the scientific solution of the problem seems to be quite possible. If we consider the fundamental form of all well-constructed vessels, we distinguish three essential parts: First, the midship, A; secondly, the fore-part, B; and, lastly, the stern, C, which we shall discuss separately.

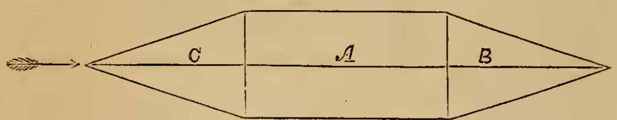


Fig. 1.

To simplify the calculation, we admit the midship to be a parallelopiped, and the fore-part, as well as the stern, a prism. We commence with the resistance of the midship, and examine afterwards the modification of that resistance by affixing prismatic bodies before and behind the midship. The experiments executed in the year 1778 by the French Academicians, D'Alembert, Bossut, and Condorcet, are alone applicable to this purpose, because the experiments of Colonel Beaufoy, made with thin plates, seem to follow other rules than the parallelopiped and the prism *closed on the back side.*

These original experiments were published in the "Memoires de l'Academie des Sciences de Paris," in the same year, 1778, and reprinted in Bossut, "Hydrodinamique," 1787; in these eighty years, since their first publication, the theory of this matter has not advanced one inch.

Although these experiments have been published so many times, it will be necessary to repeat them here again.

The apparatus was constructed according to the principles later employed by Colonel Beaufoy; the basin was 200 ft. long and 100 ft. broad; the running space had a length of 96 ft. (f, g); the observations were made with an excellent pendulum; the radius, $c\ b$, was to the radius $a\ c$, as 10 : 72; and the coefficient of friction for copper and iron = 0·160 of the weight; so that all weights observed must be reduced in this proportion.

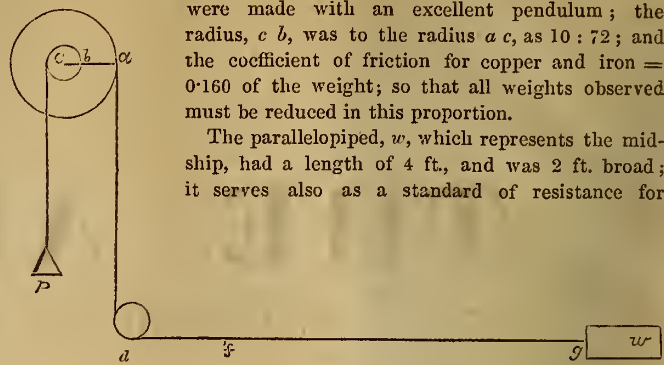


Fig. 2.

The parallelopiped, w, which represents the midship, had a length of 4 ft., and was 2 ft. broad; it serves also as a standard of resistance for the other bodies which are employed. The following tables contain five trials for this resistance for various speeds. The resistance in the last column is calculated in proportion to the square of velocity, and with the weight of 1 cubic ft. water = 70 lbs., by the known formula $\frac{v^2}{4\,g}\,\square'$.

No.	Weight employed.	Weight reduced.	Space of time.	Velocity per 1 Sec. (v).	Resistance calculated.
	lbs.	lbs.	′ ″	Feet.	lbs.
1	61 ·8	7 ·23	77 ·50	1 ·238	7 ·11
2	112 ·5	13 ·16	56 ·95	1 ·685	13 ·17
3	162 ·5	19 ·01	47 ·22	2 ·033	19 ·16
4	212 ·5	24 ·86	41 ·26	2 ·327	25 ·10
5	262 ·5	30 ·71	37 ·12	2 ·586	31 ·01

The accordance of the reduced weight and the calculated resistance, proves the accuracy of the supposed proportionality of resistance to the square of velocity, which proportionality returns likewise by bodies of another form, moved in water, with a moderate velocity, not exceeding the usual velocity of vessels. The applicability of this theorem in the arithmetic of naval architecture appears also evident; for, if we take the mile = $\frac{1}{60}^{\circ}$, the speed from 1 mile in 1 hour is equal to 1·586 ft. in 1 second. According to the above enounced theorem, the five trials above mentioned give the resistance for 4 sq. ft. by the following proportions:—

$$1{\cdot}238^2 : 1{\cdot}586 = 7{\cdot}23 : 11{\cdot}87$$
$$1{\cdot}685^2 : 1{\cdot}586 = 13{\cdot}16 : 11{\cdot}66$$
$$2{\cdot}033^2 : 1{\cdot}586 = 19{\cdot}01 : 11{\cdot}57$$
$$2{\cdot}327^2 : 1{\cdot}586 = 24{\cdot}86 : 11{\cdot}58$$
$$2{\cdot}586^2 : 1{\cdot}586 = 30{\cdot}71 : 11{\cdot}55$$

Middle = 11·64

Therefore, for *one* square foot = 2·91 lbs. French measure and weight, or for *one* square foot English = 3·58 lbs.*
and sea water = 3·69 lbs.

You will also find the resistance for 2, 3, 4, &c., miles in 1 hour by multiplying the resistance for *one* mile, = 3·69 lbs., with the square of velocity, 4, 9, 16, &c. In this way the following Table is constructed:—

Table *for direct Resistance of a Parallelopiped with a Base of* One *Square Foot Plane.*

Miles in 1 hour . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Squares. . .	1	4	9	16	25	36	49	64	81	100	121	144	169	196	225	256	289	324	361	400
Resistance in lbs. . .	3 ·69	14 ·76	33 ·21	59 ·04	92 ·25	132 ·84	180 ·81	236 ·16	298 ·89	369 ·00	446 ·49	531 ·36	623 ·61	723 ·24	830 ·25	944 ·64	1066 ·41	1195 ·36	1332 ·09	1476 ·00

II.

By the Table given in the first chapter, we are enabled to find the resistance of a parallelopiped whose length is at least the double of the breadth. By shorter parallelopipeds the results can be in some degree uncertain, but the usual dimensions of the midship should not differ much from this proportion. We are now obliged to give in the same

* 1 sq. ft. Par. = 1·14 sq. ft. English; 1 lb. poids de marc = 1·08 lb. avoirdupois.

manner the rules for calculating the diminution of resistance by adopting prismatic bodies before and behind the midship. It is evident that by these disquisitions the breadth of the base must be regarded as constant, and only the angle on the top of the prism variable—a consideration which was observed by the French experiments, but neglected by the analysts and the English experiments; this is the only cause why the problem is hitherto unresolved. When we again adopt the theorem that the resistances (R, r) are in the ratio as the squares of velocities (V, v), and the velocities, *by uniform varied movement*, in the ratio of the elapsed times (T, t), we have the proportion—

$$R : r = V^2 : v^2 = T^2 : t^2, \text{ or } \frac{r}{R} = \frac{t^2}{T^2} = \phi.$$

The times T and t are given by observation, and R represents the resistance against the base of the parallelopiped, determined at the end of our first chapter; $\phi = \frac{t^2}{T^2}$ is consequently the coefficient with which R must be multiplied to obtain the new resistance $r = \phi$ R.

The French academicians, d'Alembert, Bossut, and Condorcet, have adopted fifteen various prisms, before the parallelopiped, whose angles on the top varied from 12 to 12°, and have observed the time occupied by them in running through the space of 96 ft. The results of these observations, made by a weight of 162·5 lbs., contain the following Table:—

TABLE *of the Coefficient of Resistance of a Parallelopiped mounted with various Prisms on the Top.*

Number.	Angle on the Top.	Time employed.	Coefficient of Resistance.
	°	″	
1	Base plane 180	47·44 (T)	1·0000
2	168	47·22	0·9908
3	156	46·44	0·9583
4	144	45·35	0·9138
5	132	43·75	0·8505
6	120	41·84	0·7779
7	108	39·50	0·6933
8	96	38·05	0·6433
9	84	35·78	0·5689
10	72	34·85	0·5397
11	60	33·05	0·4853
12	48	31·61	0·4440
13	36	30·53	0·4142
14	24	30·23	0·4061
15	12	30·01	0·4003
16*	0	30·00	0·4000

* No. 16 is not observed.

These results of the observations of the French academicians have, since their first publication in the "Memoires de Paris," been reprinted in various languages, each time without naming their source. It is difficult to detect the law followed by these coefficients; to facilitate this inquiry we will construct the curvilinear trace of them by co-ordinates.

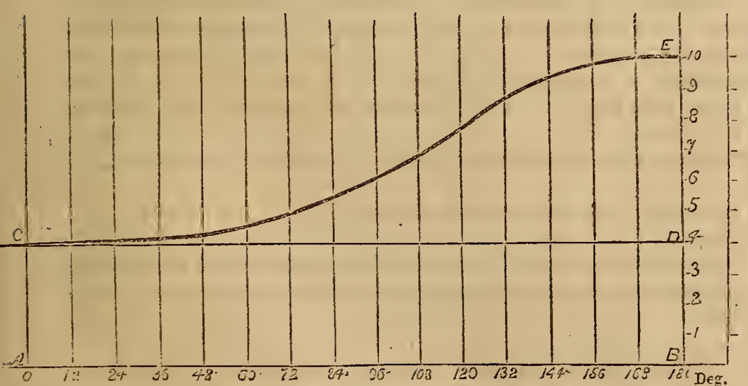


Fig. 3.

On this figure we find by the simple view that each ordinate consists of two parts; one, A C = B D, is constant and common to all; and the other seems to be a fraction of the sinus of the angle on the top. The figure gives immediately A C = B D = 4, and C D = 6, if we make B E = 10. The formula of the curve would also be : $y = 6$ sin. $a^n + 4$, where a represents the half of the angle on the top. The exponent, n, must be determined in the following way:—The formula gives $y - 4 = 6$ sin. a^n; by logarithms, log. $(y - 4) = n$ log. sin. a + log. 6; therefore, $n = \frac{\text{log. } (y - 4) - \text{log. } 6}{\text{log. sin. } a}$. The observations give with the last formula in the middle $n = 3$, with a perfect accordance. By this means, the formula becomes : $y = 0{\cdot}6$ sin. $a^3 + 0{\cdot}4$ for B E = 1. We shall now show how the calculated coefficients accord with the results of observations.

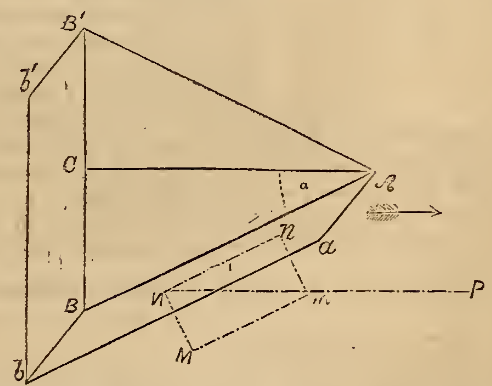
	Half Angle on the Top.	Coefficient of Resistance			Half Angle on the Top.	Coefficient of Resistance	
		Calculated.	Observed.			Calculated.	Observed.
1	90°	1·0000	1·0000	9	42°	0·5797	0·5689
2	84	0·9904	0·9908	10	36	0·5218	0·5397
3	78	0·9615	0·9583	11	30	0·4750	0·4853
4	72	0·9162	0·9138	12	24	0·4404	0·4440
5	66	0·8575	0·8505	13	18	0·4177	0·4142
6	60	0·7897	0·7779	14	12	0·4054	0·4061
7	54	0·7177	0·6933	15	6	0·4007	0·4003
8	48	0·6462	0·6433	16	0	0·4000	0·4000

III.

This harmony of the calculation and of experience proves not only the correctness of the formulæ, but also the exactness of the French experiments. It remains now to ascertain these results by theory.

Leonhard Euler gives the following demonstration of the resistance of a prismatic forebody ("Memoires de Sciences de Paris," 1778, p. 597).

A C is the axis of the prismatic forebody, which divides the



base B B′ into equal parts. We name this axis A C = a; the two sides A B = A B′ = b, and the angle B A C = a, and the height B b = c. If this prism moves itself in the direction C A with a velocity equal to v, where v indicates the space run in 1 second of time; and if we name g the height through which a body falls in the same time, the height corresponding to the velocity, v, must be equal to $\frac{v^2}{4\,g}$; therefore, when the water impinges perpendicularly in the direction M N, with this velocity on the plane, A B a b, whose area is A B × B $b = b\,c$, the power of the shock would be equal to the weight of the column of water $\frac{b\,c\,v^2}{4\,g}$. But the shock operating in the direction P N, by the angle a, the power shall be equal to $\frac{b\,c\,v^2 \text{ sin. } a^2}{4\,g}$, and the direction, m n, perpendicularly to the face, A B a b. By this we conclude the power in the direction A C equal to b c, sin. $a \frac{v^2 \text{ sin.}^2\, a}{4\,g}$

where $b\,c$, sin. a, signifies the half of the basis, B B′. The double of this power $\frac{2\,b\,c\,v^2 \text{ sin. } a^3}{4\,g}$ is the portion of the resistance produced only by the shock of water.

But this lucid demonstration of Leonhard Euler cannot be applied immediately to the observations of the French philosophers, for two reasons.

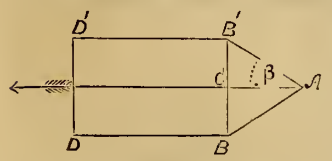
1. Because the base B B′ $b\,b' = b\,c$, sin. a, in the given formula, is variable, and will be, by $a = 0$, likewise equal to zero; whilst, on the contrary, the basis of the employed parallelopiped, furnished with prisms on the fore-end, *was constant;* and

2. Because the experiments include the effect of the friction of water on the whole body in motion, for which Leonhard Euler gives a formula, which is too complicated for use.

To reduce this formula to the given case of a constant base, we put the difference under the resistance of the parallelopiped alone, and the observed resistance of the same body mounted with a prism equal to $1 - \phi$. In regard of the friction, we introduce a simple experimental coefficient, m, in the analytical expression of the resistance, $= m\ (1 - \text{sin. } a^3)$. By these two modifications the formula would be: $1 - \phi = m\ (1 - \text{sin. } a^3)$, by which we find $\phi = m \text{ sin. } a^3 + (1 - m)$. In this last formula the exponent $n = 3$ is known, but the coefficient $m = \frac{1 - \phi}{1 - \text{sin. } a^3}$ will be determined by the observations $=$ 0·6 in the middle. The formula found by theory $\phi = 0{\cdot}6 \text{ sin. } a^3 + 1 - 0{\cdot}6 = 0{\cdot}6 \text{ sin. } a^3 + 0{\cdot}4$, is therefore *in perfect accordance with the formula above derived merely by experience.* If you require the absolute resistance in lbs., you must multiply the calculated resistance by this formula with the corresponding number given in the Table in the first chapter.

IV.

If the prismatic body is adopted behind the midship, the water coming from the two flanks, D B, D′ B′, strives to fill the vacuum caused by the movement of the vessel on the sides, B A, B′ A, on the afterbody, and produces a shock forwards. In a similar way the forebody produces a similar effect; therefore it will be permitted to make use of the same formula as in the former case, but with another coefficient, m', derived from observations made especially for this purpose.



The French academicians give in the cited Memoires also, for this case, four observations, made with the same apparatus as in the former experiments. By these observations we find immediately the coefficient of the resting resistance $\phi' = \frac{t^2}{T^2}$; and by this the coefficient of propulsion $1 - \phi' = 1 - \frac{t^2}{T^2}$ as follows:—

Half Angle on the Afterbody.	Time employed.	Coefficient	
		of Resistance.	of Propulsion.
°	″		
90	47·44	1·0000	0·0000
48	44·80	0·8918	0·1082
24	43·85	0·8544	0·1456
12	43·49	0·8404	0·1596

These four observations give $m' = \frac{1 - \phi'}{1 - \text{sin. } \beta^3} = \frac{1}{6} = 0{\cdot}167$. The formula for the propulsion of the afterbody is therefore $1 - \phi' = 0{\cdot}167\ (1 - \text{sin. } \beta^3)$, which must be subtracted from the resistance of the forebody. We are now enabled to calculate the whole diminution of the resistance of the midship, produced by application of a prismatic forebody and afterbody at the same time. For facilitating this calculation we give the coefficients of resistance of the forebody, and the coefficients of propulsion of the afterbody, in the following Table:—

TABLE *of the Resistance of the Forebody, and of the Propulsion of the Afterbody.*

Half Angle on the Top.	Forebody Resistance.	Afterbody Propulsion.	Half Angle on the Top.	Half Angle on the Top.	Forebody Resistance.	Afterbody Propulsion.	Half Angle on the Top.	Half Angle on the Top.	Forebody Resistance.	Afterbody Propulsion.	Half Angle on the Top.
°	+	—	Rate.	°	+	—	Rate.	°	+	—	Rate.
0	0·400	0·167	0·00	31	0 482	0·144	0·60	62	0·813	0·055	1·88
1	0·400	0·167	0·02	32	0·489	0·142	0·62	63	0·824	0·052	1·96
2	0·400	0·167	0·03	33	0·497	0·140	0·65	64	0·835	0·050	2·05
3	0·400	0·167	0·05	34	0·505	0·138	0·67	65	0·846	0·048	2·14
4	0·400	0·167	0·07	35	0·514	0·136	0·70	66	0·857	0·045	2·25
5	0·401	0·167	0·09	36	0·522	0·133	0·73	67	0·868	0·043	2·36
6	0·401	0·166	0·10	37	0·531	0·130	0·75	68	0·878	0·040	2·47
7	0·401	0·166	0·12	38	0·540	0·128	0·78	69	0·888	0·038	2·60
8	0·401	0·166	0·14	39	0·549	0·126	0·81	70	0·898	0·035	2·75
9	0·402	0·166	0·16	40	0·560	0·123	0·84	71	0·906	0·033	2·90
10	0·403	0·166	0·18	41	0·670	0·120	0·87	72	0·915	0·030	3·08
11	0·404	0·166	0·19	42	0·580	0·117	0·90	73	0·922	0·027	3·27
12	0·405	0·165	0·21	43	0·690	0·114	0·93	74	0·932	0·025	3·49
13	0·406	0·165	0 23	44	0·601	0·111	0·96	75	0·940	0·022	3·73
14	0·408	0·164	0·25	45	0·612	0·108	1·00	76	0·946	0·020	4·01
15	0·410	0·164	0·27	46	0·623	0·104	1·03	77	0·952	0·017	4·33
16	0·412	0·163	0·29	47	0·634	0·102	1·07	78	0·958	0·015	4·70
17	0·415	0·162	0·30	48	0·646	0·098	1·11	79	0·964	0·012	5·14
18	0·418	0·162	0·32	49	0·658	0·094	1·15	80	0·970	0·010	5·67
19	0·421	0·161	0·34	50	0·670	0·092	1·19	81	0·976	0·007	6·31
20	0·424	0·160	0·36	51	0·682	0·088	1·23	82	0·983	0·005	7·11
21	0·428	0·159	0·38	52	0·694	0·085	1·28	83	0·985	0·004	8·14
22	0·431	0·158	0·40	53	0·706	0·082	1·33	84	0·987	0·003	9·51
23	0·436	0·157	0·42	54	0·718	0·078	1·38	85	0·989	0·003	11·43
24	0·440	0·156	0·44	55	0·730	0·075	1·43	86	0·991	0·002	14·30
25	0·445	0·154	0·47	56	0·742	0·072	1·48	87	0·993	0·001	19·08
26	0·450	0·153	0·49	57	0·754	0·069	1·54	88	0·996	0·001	28·63
27	0·456	0·151	0·51	58	0·766	0·066	1·60	89	0·998	0·000	37·29
28	0·462	0·150	0·53	59	0·778	0·062	1·66	90	1·000	0·000	∞
29	0·468	0·148	0·55	60	0·791	0·059	1·73				
30	0·475	0·146	0·58	61	0·802	0·057	1·80				

V.

The application of this Table is simple and easy, and it can be employed in two ways, *i.e.*, either for the given angle in degrees on the top, or for the given rate of the height to the half-basis of the isosceles prism. For illustrating this calculation, we choose the following interesting example. According to published statements, the dimensions of the *Great Eastern*, or *Leviathan*, are:—

Breadth from side to side of hull = 83 ft.
Draft of water, laden, = 30 ft.
Rate of the forebody, 330 : 41·5 = 1 : 0·12.
Rate of the afterbody, 230 : 41·5 = 1 : 0·18.

The midship section is supposed to be nearly quadrangular, and the speed 16 miles per hour. Hereafter, the area of the midship section is found 83 × 30 = 2,490 sq. ft.

For the speed intended of 16 miles per hour, the Table in Chapter I. gives 945 lbs. The resistance of the midship by this speed will be found 2490 × 945 = 2,353,000 lbs. The coefficient of resistance of the forebody for the rate 1 : 0·12 is given in the last Table = 0·401; and the coefficient of propulsion of the afterbody for the rate 1 : 0·18, we find in the same table = — 0·166; therefore the resistance of the forebody is 2,353,000 × 0·401 = ... 943,553 lbs.
The propulsion of the afterbody, 235,300 × 0·166 = ... — 390,598 „

Diminished resistance of the whole vessel = ... 552,955 „
Or, divided by 555 lbs., = ... 996 H.P.

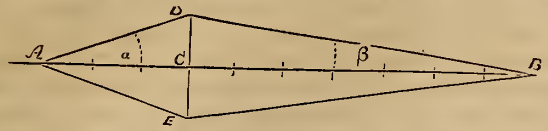
Mr. Brunel has adopted 1,000 H.P. for the nominal power of the paddle-engines alone of the *Leviathan*, which accords nearly with our calculation.

VI.

The last Table, of the shock against the forebody and the afterbody, can be used to resolve a problem of the greatest importance for naval architecture. If we combine two prisms of the same basis, whose two lengths being variable, give, added together, a constant sum, we can find a certain proportion of the two lengths A C : B C, where the diminu-

tion of resistance produced by the united forebody and afterbody is a maximum, or the resistance itself a minimum.

For instance, the constant sum of the two lengths $AC + BC = AB$,



shall be = 10, and the half-breadth = 1. If we now combine the forebody A D E with the afterbody B D E, we find in the Table—

a, the resistance of the forebody,
A D E for the rate $AC : CD = 3 : 1 = 1 : 0{\cdot}33 = 0{\cdot}419$
b, the propulsion of the afterbody,
B D E for the rate $BC : CD = 7 : 1 = 1 : 0{\cdot}14 = 0{\cdot}166$

c, remaining resistance of the whole body .... $= 0{\cdot}253$

If we combine in this manner the several lengths 1 : 9, 2 : 8, 3 : 7, &c., whose sum is always = 10; and if we vary the half-breadth from 1 to 2 and 3, we obtain the following series of resistances:—

Proportion of the lengths.	Resistance.		
AC : BC	Half-breadth = 1.	Half-breadth = 2.	Half-breadth = 3.
1 : 9	0·446	0·664	0·751
2 : 8	0·287	0·448	0·586
3 : 7	0·253	0·340	0·456
4 : 6	0·243	0·292	0·378
5 : 5	0·239	0·273	0·338
6 : 4	0·238	0·267	0·323
7 : 3	0·240	0·274	0·329
8 : 2	0·241	0·301	0·355
9 : 1	0·293	0·359	0·395

By these empirical results it is evident that the *minimum of resistance* of combined prisms takes place when the proportion of the two lengths is $AC : BC = 6 : 4$, within the indicated limits of breadth.

These limits we find as follows:—the analytical formula for the resistance of the combined prisms is—

$$\phi - \phi' = m \sin. \alpha^3 - m^1 \sin. \beta^3 - (m - m^1).$$

For the resolution of our problem, it is necessary to express the angles α and β as functions of the rates $AC : CD$ and $BC : CD$. We name $AC = x$, $CD = b$, and $BC = 1 - x$. Therefore, $\sin. \alpha = \frac{CD}{AC} = \frac{b}{\sqrt{b^2 + x^2}}$, $\sin. \beta = \frac{CD}{BC} = \frac{b}{\sqrt{b^2 + (1 - x^2)}}$, and the equation of the minimum of resistance will be—

$$0 = d\left(\frac{m\, b^3}{(b^2 + x^2)^{\frac{3}{2}}} - \frac{m^1\, b^3}{(b^2 + (1 - x)^2)^{\frac{3}{2}}}\right)$$

$$= -\frac{3\, m\, b^3\, x\, d\, x}{(b^2 + x^2)^{\frac{5}{2}}} + \frac{3\, m^1\, b^3 (1 - x)\, d\, x}{(b^2 + (1 - x)^2)^{\frac{5}{2}}}$$

$$\text{or, } \frac{m\, b^3\, x}{(b^2 + x^2)^{\frac{5}{2}}} = \frac{m^1\, b^3 (1 - x)}{(b^2 + (1 - x)^2)^{\frac{5}{2}}}$$

In this formula m and m^1 are known by experiments, and b must be given. The more commodious form for the calculation will be—

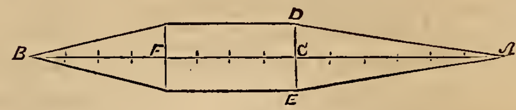
$$\frac{m}{m^1} = \frac{(1 - x)(b^2 + x^2)^{\frac{5}{2}}}{x\,(b^2 + (1 - x)^2)^{\frac{5}{2}}} = 12{\cdot}96.$$

The direct solution of this equation is very difficult, but the indirect solution gives results sufficiently précise for all practical purposes. In this way we have found for the half-breadth b, in parts of the whole length, the length of the forebody x, and of the afterbody $1 - x$, as follows:—

$b = \frac{1}{10}$ .... $x = 0{\cdot}58$ .... $1 - x = 0{\cdot}42$
$b = \frac{2}{10}$ .... $x = 0{\cdot}59$ .... $1 - x = 0{\cdot}41$
$b = \frac{3}{10}$ .... $x = 0{\cdot}62$ .... $1 - x = 0{\cdot}38$
$b = \frac{4}{10}$ .... $x = 0{\cdot}66$ .... $1 - x = 0{\cdot}34$

By this the limits of the whole breadth are $\frac{2}{10}$ and $\frac{6}{10}$ of the length of the vessel.

But the numbers of our Table being deduced from experiments made with a prism which was affixed to a parallelopiped, whose length is nearly the double of the breadth, it is necessary to put between the forebody and the afterbody a parallelopiped of these dimensions. According to theory, the best form of a vessel will therefore be for the breadth = 2.



Length of the forebody ....A C = 6
" midship ....C F = 4
" afterbody..................F B = 4

Whole length of the vessel.................. 14

The dimensions of the *Leviathan* above given are, at the load-line, nearly in this proportion.

(*To be continued.*)

ANALYSES OF GAS COMPANIES' ACCOUNTS.

(Continued from p. 150, Vol. xv.)

CHARTERED GAS CO.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
RECEIPTS.	£	£	Pence.
Gas Rental	92186	1720	35·90
Coke and other products	16625	310	6·47
	108811	2030	42·37
EXPENDITURE.			
Coals	53591	1000	20·87
Retorts	2355	44	·92
Lamps & Lighting..	1737	32	·67
Carrying on Works	2854	53	1·11
General Wear and Tear............	3708	69	1·44
Meters, and Fixing	2837	53	1·11
Paving	679	13	·27
Directors&Auditors	1163	22	·46
Salaries and Commission	4993	93	1·94
Wages and Contingencies	11223	209	4·36
Taxes(including Income Tax)......	2514	47	·98
Law expenses	37	61	·02
Bad Debts	947	18	·38
Profit	20173	376	7·85
	108811	2030	42·37
SUMMARY AND PROOF.			
Rental	92186	1720	35·90
Manufacture..88638			
Less Res. Pro.16625	72013	1344	28·05
Profit	20173	376	7·85

LONDON GAS CO.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
RECEIPTS.	£	£	Pence.
Gas Rental	53917	1994	41·61
Coke and other Products...........	14665	542	11·31
	68582	2536	52·92
EXPENDITURE.			
Coals	27037	1000	20·87
Lime	296	11	·23
Stores............	1043	39	·81
Wages............	7795	288	6·01
Wear and Tear	1957	72	1·50
Royalty	562	21	·44
Meters	1508	56	1·17
Directors&Auditors	530	20	·42
Salaries	1626	60	1·25
Rates and Taxes ..	780	29	·60
Commission	854	32	·67
Stationery and Incidentals........	743	27	·56
Allowances, & Bad Debts	1986	73	1·52
Law expenses	500	18	·38
Depreciation	7730	286	5·97
Profit............	13635	504	10·52
	68582	2536	52·92
SUMMARY AND PROOF.			
Rental............	53917	1994	41·61
Manufacture. 54947			
Less Res. Pro. 14665	40282	1490	31·09
Profit	13635	504	10·52

Equitable Gas Co.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
Receipts.	£	£	Pence.
Gas Rental	27155	2065	43·10
Coke and other Products	4086	311	6·49
	31241	2376	49·59
Expenditure.			
Tradesmen's Bills	542	41	·86
Coals	13148	1000	20·87
Wages	3427	261	5·45
Rent, Rates, and Taxes	377	29	·60
Directors & Auditors	405	31	·65
Salaries	950	72	1·50
Collectors' Commission	378	29	·61
Stationery, &c.	246	18	·38
Wear and Tear	4157	316	6·59
Profit	7611	579	12·08
	31241	2376	49·59
Summary and Proof.			
Rental	27155	2065	43·10
Manufacture . 23630			
Less Res. Pro. 4086			
	19544	1486	31·02
Profit	7611	579	12·08

Phœnix Gas Co.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
Receipts.	£	£	Pence.
Gas Rental	56659	2159	45·06
Coke and other Products	13175	502	10·48
	69834	2661	55·54
Expenditure.			
Coals	26246	1000	20·87
Tradesmen's Bills	6335	241	5·03
Retorts used	590	23	·48
Meters	1883	72	1·50
Rent, Rates, and Taxes	1812	69	1·44
Directors & Auditors	800	31	·65
Salaries	2752	105	2·19
Wages	8739	333	6·95
Bad Debts & Overcharges	631	24	·50
Depreciation	4185	159	3·32
Profit	15861	604	12·61
	69834	2661	55·54
Summary and Proof.			
Rental	56659	2159	45·06
Manufacture . 53973			
Less Res. Pro. 13175			
	40798	1555	32·45
Profit	15861	604	12·61

South Metropolitan Gas Co.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
Receipts.	£	£	Pence.
Gas Rental	24569	2172	45·33
Coke and other products	5053	447	9·33
	29622	2619	54·66
Expenditure.			
Wages	3892	344	7·18
Salaries	917	81	1·69
Directors, &c.	385	34	·71
Lamps	1281	113	2·36
Rent and Taxes	719	64	1·34
Purifying Materials	337	30	·63
Sundries	1054	93	1·94
Coals	11310	1000	20·87
Wear and Tear of Retorts	516	46	·96
Mains laid and repaired	1335	118	2·46
Service pipes ditto	385	34	·71
Meters	774	68	1·42
General Stores	180	16	·33
Bad Debts	224	20	·42
Profit	6313	558	11·64
	29622	2619	54·66
Summary and Proof.			
Rental	24569	2172	45·33
Manufacture . 23309			
Less Res. Pro. 5053			
	18256	1614	33·68
Profit	6313	558	11.65

City of London Gas Co.
Half Year ending June, 1857.

	Gross.	Per £1000 worth of Coal.	Per 1000 ft. of Gas.
Receipts.	£	£	Pence.
Gas Rental	37545	1920	40·07
Coke and other Products	8831	451	9·41
	46376	2371	49·48
Expenditure.			
Coals	19554	1000	20·87
Rent, Rates, & Taxes	1637	84	1·75
Wages	6837	349	7·28
Directors & Auditors	516	26	·54
Salaries	1815	93	1·94
Tradesmen's Accounts	4471	228	4·76
Repairs, &c.	364	18	·38
Petty Cash	373	19	·40
Bad Debts	373	19	·40
Profit	10436	535	11·17
	46376	2371	49·48
Summary and Proof.			
Rental	37545	1920	40·07
Manufacture . . 35940			
Less Res. Pro. 8831			
	27109	1385	28·90
Profit	10436	535	11·17

THE LIFFEY.

(From our Dublin Correspondent.)

The River Liffey has its source in the Kippure Mountains, and from that source, until it reaches the metropolis, is a singularly pure and limpid stream, and would so continue till it reached the sea but for the pollution it receives in the sewage of the city. This is a matter of the utmost consequence to the citizens, and a great number of plans have been from time to time brought forward to cure or prevent the evil. Some of these were untenable from the vast outlay required, and others from their interference with the waterway of the river. The system of sewers, as laid down by the borough engineer, would in part get over the evil; but the carrying out of these will be a work of time and labour, if, indeed, they will ever be carried out; and even they have one or more out-falling main sewers emptying into the river.

Conceiving that to remove the sewage entirely from the river is a project too Utopian in its character ever to be attained to, we will now discuss two plans—each good, and each decidedly original. The first, that of a non-professional gentleman (Mr. Stark, of Sackville Street), is to pitch pave, or flag the river at either side to a very sharp incline, forming in the centre a V shaped drain; this flagging or paving to commence at the King's, and end a little below Carlisle Bridge. The good effect of this arrangement is obvious. All the lighter particles of matter would be swept down by the increased current caused by the confining of the channel within regular bounds; and for the heavier particles, they could be swept into the central channel occasionally by the scavengers. The cost of this arrangement, though at first sight it might appear large, would not be so in reality, considering the great appliances that the Corporation, for Preserving and Improving the Port, have at their command.

The greater portion of the bed of the river is left dry, or nearly so, at each low tide, and, by damming a portion of one side of the bed alternately, the work would proceed with a celerity that only those who know how very speedily the men of the Corporation can accomplish their Herculean feats would believe possible; and the materials can be had in abundance for the dredging.

Previous to the year 1850, the Strand below the patent slip at Halpin's Pool was in a state of nature; since that time the men of the Ballast Board have dredged and deposited a bank of earth averaging 20 ft. in height, about 1,500 ft. in length, by about 1,000 ft. in breadth; or, in round numbers, something like 30,000,000 cubic ft. of stuff, consisting of stones, sand, and gravel, in the heart of which the new graving dock has been built. To a Corporation that can accomplish such a labour as this in seven years, the paving or flagging of a mile and quarter of the bed of the river would be a mere bagatelle; and if, in connection with this plan of Mr. Stark's, Mr. Niven's suggestion of planting the sides of the quays with large trees was adopted, a real blessing would be conferred on the citizens.

The second design, although not so simple as that we have just noticed, is not without its merits, and contains some points of originality. Its author is Mr. J. S. Sloane, an engineer, who has given considerable time and attention to projects for the improvement of his native city. It consists in laying a cast-iron sewer in the bed of the river, commencing above the outfall of the highest of the present sewers. From each of these sewers he proposes to carry a cast-iron pipe of sufficient caliber to take their contents and convey them into the main cast iron tube or sewer; thus (although using the bed of the river as a convenient place to lay his pipe) cutting off from the water all pollution, and permitting it to reach the sea pure as when it left the rugged rocks of "Poul a Phoca."

There are many difficulties in this plan, but they have been apparently so well considered by Mr. Sloane that they cease to appear as such; and his plan has, without doubt, many claims on the people of Dublin.

Supposing his tube laid down in the central bed of the river, the difficulty of disposing of the contents appear great; but he at once gets rid of that, by showing that he intends the tube or sewer to turn round in front of the Dodder River, penetrating beneath the Pigeonhouse Road, and so out to the Strand between the Pigeonhouse and Sandy Mount, where it would empty its contents into a tank built for the purpose, sufficiently large to contain them. From thence a steam or water engine of moderate power would pump the sewage to a level considerably over high-water mark, where the solid portions being collected for manure, the liquid, if not required, could be permitted to run off into the sea near Poolbeg Lighthouse, thus leaving the river free to its mouth of all the influences that have for so many years caused it to be regarded as one of the pests of the city.

As the fall in this tube would be very small, some means of flushing would be requisite: and this is provided for by turning up the upper end of it to nearly the high-water level of the river, and closing it with a valve worked by a screw. Every day at high water this valve could be opened and a flow sufficient to flush the entire length of the pipe

admitted, which would be carried off along with the other waste water when it arrived at the tank.

The plan of collecting the sewage of the city and disposing of it to farmers is not at all new, but the carrying of it out so far from the city, and collecting it on the waste strand of Irishtown, has many points of novelty to recommend it to notice. That there are plenty of funds to carry out either of these designs, is proved from the fact that the Corporation have lately carried out the following works, more costly than useful, viz.:—A 10-ton crane. A strange looking landing-stage, on a few piles at the point of the wall, and in the course of vessels entering and leaving the harbour — constructed on the "cheap and nasty" principle. And last, though by no means least, a timber wharf, is proposed at a part of the river where nobody lives excepting two publicans, and a timber merchant, who always finds it more convenient to discharge his vessels into the water at once, than bring them into the river. Thus we see that it is not for want of money that the river is not improved; and as we have shown the way in which it may be done, we trust that we may live to see either of the designs accomplished.

The shipbuilders are making a great outcry about the delay to the completion of the new graving dock, but they must study patience, as neither engines to pump the dock dry, nor an engine well, have been as yet commenced; and there is also the removal of the great bank of earth in front of the dock to be accomplished before a vessel can enter.

IRISH POSTAL COMMUNICATION.

THE Directors of the City of Dublin Steam Packet Company have given notice, that in consequence of having completed arrangements with the several shipbuilders and engineers about to construct for them four new steam vessels, it will be necessary to create additional capital, and are about to offer, at par, the unissued £50 shares of the company, to the number of 2,083—which in the first instance are to be offered to the proprietors of the City of Dublin and Dublin and Liverpool Steamship Companies, and in the event of any remaining over, they will be disposed of to non-proprietors.

These steam vessels are to be constructed each of 2,000 tons measurement, and are to be engaged in the new postal and passenger service between Dublin and London.

The interest proposed to be paid on the shares is at the rate of 6 per cent. per annum; but the City of Dublin Company are to have the right to re-purchase them at par at the end of the fifth year, provided three months' notice in writing be given to the proprietors of such intention.

It is at the same time agreed, that the proprietors shall have a corresponding right to receive back their advance of capital at the end of the fifth year, provided due notice be given. The object of this stipulation is, that the Government having reserved power to terminate the postal contract at the end of the five years, should they have sufficient reason to be dissatisfied with the manner in which it has been performed, the Company wish to guard themselves from the possible contingency of having to pay interest on capital for which they may have no profitable employment.

HORNE'S IMPROVED WOOD PLANING MACHINE.

(Illustrated by Plate cxxi.)

THE subject of the employment of machinery for working wood has recently attracted considerable attention, more immediately, perhaps, in consequence of the very able paper by Mr. Molesworth, which was read by him at a recent meeting of the Institution of Civil Engineers, and briefly reported in THE ARTIZAN for December, 1857, page 281, and at page 11 of this Volume.

On a recent visit to Woolwich Dockyard, our attention was attracted to a planing machine at work there for preparing wood stuff of various kinds for dockyard use, and its very satisfactory performance, both as to the superior quality and amount of work produced, was evident after a careful inspection; and, moreover, as the executive officers connected with the department to which the machine belongs spoke so favourably of it as a really valuable improvement over other planing machines, we believe we should be neglecting our duty to our Subscribers if we did not describe and illustrate these improved wood planing machines.

Upon the present occasion we purpose only referring to its capabilities, deferring until next month, when we shall be enabled to give the Plate, a literal description of the various parts of the machine, together with the mode of working it.

The machine we have seen at work will plane, groove, tongue, square, or bevil, and thickness boards at the rate of 50 ft. per minute: it will take in stuff from 12 in. to 2½ in. in width, and of a thickness from 6 in. to ⅜ths of an in. Having strong framing and powerful gearing, of the most simple and accurate construction, it is well adapted for shipbuilders' purposes, as for planing and preparing deck-planks of any thickness; and, as any required bevil can readily be given to the edges of such planks whilst passing through the machine, the advantages of such a machine offer for making accurate caulking joints will be readily understood.

In addition to preparing flooring boards and deck planks, the same machine may be advantageously employed for squaring up scantling for carpenters' work, for bulk heads, panelling, linings, &c.

INSTITUTION OF CIVIL ENGINEERS.

After the Address of the President, Joseph Locke, Esq., M.P., which we gave in THE ARTIZAN for February, the Paper read was ON SELF-ACTING RAILWAY BRAKES, by Mons. Guérin. As a lengthy description, with a copper-plate engraving appeared in the November (1857) Number of THE ARTIZAN, we need not refer to it again, but present our readers with an abstract of such parts of the discussion as may be likely to prove of interest.

The discussion upon Mons. Guérin's Paper "On Railway Brakes" was continued throughout the evening of January 19.

It was remarked that, in 1841, the late Mr. George Stephenson had stated, before a Select Committee of the House of Commons, that brakes had a very important influence upon the safety of railway travelling, and expressed the opinion, that if a self-acting brake power could be brought to bear simultaneously upon all the carriages in a train, it would be infinitely superior to a separate brake and brakesman to each carriage.

The non-success of many plans which had been tried was attributed to the desire to make them automatic, the apparatus for which prevented the free use of the brake in shunting, or when standing in sidings.

A description was then given of

MR. NEWALL'S SYSTEM OF BRAKES, which had been in successful operation for the last five years, on the East Lancashire Railway, and which was fitted to all the rolling stock on the Manchester, Sheffield, and Lincolnshire, and on the St. Helen's Railways. It was also in partial use on six or seven other English lines, as well as on the Great Northern of France. This system was not intended to be automatic, except in such cases as the breaking loose of a portion of the train, or the liberation of the catches by some violent action. The guard, or engine-driver, could instantly and simultaneously apply all the brakes in a train, which were only kept out of action by a balance-catch, easily liberated. In ordinary brakes, power was required to apply the pressure; but in Mr. Newall's system, on the contrary, power was necessary to remove it. In this apparatus a spiral steel spring, 3½ in. in diameter, contained in a cylinder, operated upon the brakes, either through the intervention of a long lever, when placed vertically, or directly on an arm of the rocking-shaft, when placed horizontally. The whole of the brakes were connected together by a long shaft running under the carriages, throughout the entire length of the train. The spring was drawn up, ready for action, by means of a rack, having a piston-head working through the open end of the cylinder. The opposite end of the rack was connected either with the long lever, or with the arm of the rocking-shaft. As this rack was geared by a pinion with the shaft running the length of the train, it would be evident that all the brake springs would be operated upon at the same moment. The long bar was made to revolve through bevil gearing at each end of an upright shaft connnected with the guard's handle, on the spindle of which a ratchet-wheel was set; this was prevented from revolving by a light catch, weighted at the opposite end, so as to fall off readily, and to keep out of action, except when put on by hand. Whenever this catch was released, the brakes instantaneously came into action. This could be effected either by a slight reverse motion of the guard's handle, or of that of the tender-brake, or by a signal cord, such as was used on the Great Northern Railway, or by a small incline plane attached to the fixed signals on the line, or a hand-block laid between the rails, which, catching the foot-roller of the upright bar, forced it up, and lifted the catch.

The connecting-bar, running the whole length of the train, was made of iron tubing, 2 in. in diameter, with an extending slide, about 6 ft. in length, of square iron, working in a steel square in the tube. This allowed for the different lengths of the buffers, and the extension of the train; whilst the double ball and socket joints at each coupling allowed for the differences in the heights of the carriages, and for the curvature of the trains.

Several applications of the same principle were described, including a tender fitted with the hanging, or flap brake, with the long lever and vertical spring, and the ordinary slide brake with the rocking shaft, but with the spring placed horizontally under the carriage, so as to have a direct motion upon the arm. The vertical spring arrangement was considered the best.

During the year 1853, two trains were run daily between Manchester and Colne, with a view of testing the comparative amount of injury to the railway and rolling stock, where a single ordinary brake was used, and where Mr. Newall's brake was employed. The result was, that after running 47,000 miles, the van wheels of the latter, on being swung, were found to be worn equally; whilst the wheels of the ordinary brake-van had to be turned up thrice during the twelve months.

The increased brake power enabled the train to be brought up within a much shorter distance. With a train composed of ten carriages, eight of which were fitted up with Mr. Newall's brakes, and two with ordinary brakes, giving a gross weight of train, inclusive of engine and tender, of 88 tons on a level line, with one ordinary brake applied, at a speed of 40 miles per hour, the train was stopped in 800 yards. With two ordinary brakes applied, at a speed of 42 miles per hour, the train was stopped in 620 yards. With Mr. Newall's brakes, at a speed of 50 miles, the train was stopped in 310 yards; at a speed of 48 miles, in 192 yards; at a speed of 40 miles, in 138 yards; and at a speed of 33 miles, in 120 yards; at a speed of 48 miles, in 371 yards, when descending 1 in 40; at a speed of 45 miles, in 430 yards, when descending 1 in 38; and at a speed of 38 miles, in 218 yards, when descending 1 in 532. In every case the ordinary brake on the tender was used.

Mr. Newall's brakes had not been found to get out of order, and the *employés* had great confidence in their action. The prominent advantages were, promptness of action—bringing up the train steadily without any jerking and consequent risk of breakage—being self-acting, when any accident happened—and each single vehicle, being fitted with the apparatus, formed a complete brake.

A review was given of the various "brakes" that had been attempted, and had been partially introduced, commencing with that applied by Mr. George Stephenson, in 1832, upon the Liverpool and Manchester line, which was

described before a Committee of the House of Commons, in 1833, by Mr. Robert Stephenson. This break was at that time proposed to be worked by the momentum of the train.

Lord Dundonald's system, in 1835, of reversing the engine and carriage frames from above to below the axles, and the use of sledge brakes, was also explained.

Then came Mr. W. B. Adams, in 1838, with a system of brakes, to act by nipping the upper tables of the rails between two horizontal bars, like a parallel ruler.

In 1839, Mr. James Nasmyth, whose self-acting brakes were tried on the Leeds and Manchester line. These brakes acted through the medium of the buffer-rods, but they had such serious defects as prevented their general use.

In 1840, Mr. W. B. Adams specified a system of brakes acting through the buffer-rods, and the same principle was again tried in 1852 by Major Robbins; there were, however, inherent defects which precluded success. In 1842, Mr. Lee brought forward a brake, which was subsequently tried on the Eastern Counties Railway; it was a sledge brake; but like those of Mr. Bodmer, in 1844, and of Mr. W. B. Adams in 1846 and 1851, it was not successful.

In 1852, Mr. Handley's brakes were applied to tank engines on the Eastern Counties Railway. They were somewhat similar to those of Mr. Lee, but at great speeds fracture appeared to be inevitable. At about the same time, Mr. D. Gooch applied sledge brakes between the driving wheels of a tank locomotive, but that system was abandoned.

Mr. Newall's system of brakes varied from all these in two important particulars. Every carriage of the train could have brakes applied by the guard, and all the brakes were previously prepared for instantaneous action in case of emergency. The disadvantages were in its being necessary to connect all the brakes together by a continuous length of shafting. It was admitted, that the advantage of applying the brakes by the agency of springs was fully attained, although the brakes could not be called "self-acting," inasmuch as the manual labour of winding up the racks and throwing off the catch was always necessary, except where provision was made for putting on the brakes by means of an inclined plane upon which the shaft touched in travelling over it.

Mr. Chambers' brake, which had been tried on the North London Railway, was described :—A wheel was applied beneath the carriage frame so as to slide longitudinally, and a short leather band passed from this wheel to one of the axles. By a slight pressure on a lever, the guard moved the wheel forward, so as to tighten the band on the axle, when the wheel moved round and acted upon the brakes. Here the force of momentum was used to apply the power very gradually.

Mons. Lefevre applied the momentum through the buffer rods by the agency of one of the buffer springs, which was made to slide forward in its bed. In this system there was not any mode of lifting the brakes out of gear, when it was necessary to back the train, unless it was done by hand, and a connecting process was needed in making up the train.

Mons. Guérin's brakes acted by the momentum of the train through the medium of the buffer spring, which was also made to slide forward, but with the important difference to all the others of the momentum of the train being made to act upon a centrifugal governor on the axle of one pair of wheels. This contrivance enabled a lock-bar to be thrown in or out of gear, and so to regulate the action of the brakes, without any manual labour, as to permit the backing of the carriages, and to do away with any continuous connection.

It was evident that in all the self-acting brakes, acting through the momentum of the buffers, the engine and tender were the fulcrum of resistance on which the momentum must impinge. It was found in practice that the momentum of four carriages was requisite to give sufficient pressure on the brakes. Thus, several carriages not being acted upon, a hand brake became necessary. For this purpose, therefore, Mr. Chambers' brake seemed to be best adapted, as requiring little hand power.

The skidding of the wheels was no doubt a great evil, to be avoided by any means. It was believed that a sledge brake acting on the rails, through the agency of springs, by the action of the buffers, was the true principle yet to be worked out. By such a process the wheels and the rails would both be saved from injury, and the automatic regulator of Mons. Guérin was a piece of mechanism that could not be dispensed with.

It was shown that the expense of adapting Newall's brakes to an old carriage would be about £12, and to a new carriage would be about £25. The use of these brakes was found to be very satisfactory on all the lines to which they had been applied. On the East Lancashire Railway they had been used for about five years, and on the South Western Railway it had been found that, by the facility they afforded in stopping at numerous stations, about 15 minutes was saved in the journey between London and Windsor. Several engineers had recently made a journey to France expressly to examine Guérin's brake, and they were able to bear very satisfactory testimony to the merits of the system, which had been applied to 200 carriages on the Orleans Railway alone, and during upwards of three years had been generally approved.

It was noticed, as a peculiarity, that soft cast iron was used instead of wood for the brake blocks, and if it did not produce a bad effect upon the tyres, the substitution would be economical.

It was observed that there were cases when the proper moment for applying the brakes could only be perceived by the driver, or by the guard, separately or simultaneously. It appeared that Newall's brake could be so used; but it was doubted whether, under Guérin's system, which acted only by the pressure of the buffers, the same effect would be as quickly obtained.

In case of a train of carriages getting off the rails, on longitudinal timbers, a distance of a quarter of a mile had been known to be passed over before the train was brought to rest. Now, with brakes that acted too rapidly, the danger was that the carriages would be thrown upon each other, and great injury would ensue. In such cases the application of automatic brakes was questionable.

In ordinary trains the brakes were now only attached to the guard's van and the tender. If, therefore, by the new system, automatic brakes were to be applied to the carriages, they must be adapted to all, as, in the making up of mixed trains, it would be inconvenient to have only a partial adaptation. Both Newall's and Guérin's plans were simple, and well adapted to their purposes; the latter being rather the simpler of the two, and they certainly merited a full experiment.

High eulogiums were passed upon the ingenuity of both systems, and whilst it was admitted that they were susceptible of being made very useful, their adoption must not be forced upon railway companies until, by continued use for some considerable period, their merits and capabilities were fully developed.

ON THE SAVING OF DEAD WEIGHT IN PASSENGER TRAINS.

By Mr. Charles Fay, of Manchester.*

The question has often arisen, though not satisfactorily answered,—Why should it take more dead weight to carry a passenger by railway than formerly by a stage coach? The two modes of transit scarcely admit of a fair comparison, as a stage coach runs singly and at a slow speed, and only one-fourth of the passengers are carried inside, the other three-fourths being outside; and when required to be brought to a stand, it is done without any violent or sudden shock or strain on the vehicle: whereas on a railway a large number of carriages are coupled together, the train travels at a high speed, and is often suddenly checked and shunted with great force into a siding, coming into contact with heavy waggons without buffer springs; the carriages have therefore to be built sufficiently strong to withstand the strains and shocks to which they are subjected. Although it is not a practical comparison, as passengers cannot be carried outside on railway carriages, yet if the mode of carrying passengers by stage coach be applied to railways, the following will be the results:—an ordinary four-horse stage coach, seating 4 inside and 12 outside, or a total of 16 passengers, and weighing about 20 cwt., gives an average of 140lbs. of dead weight to each passenger. Now if this be compared with one of the large third-class carriages built by the writer for the Lancashire and Yorkshire Railway, and now running on the Oldham branch, which are 28 ft. long, 8 ft. 6 in. wide, seating 84 passengers, and weighing 6 tons $11\frac{1}{2}$ cwt., then, supposing passengers were carried on the roof in addition, as on a stage coach, it would seat about 84 more, allowing 16 inches for each passenger, or a total of 168 passengers, which gives an average of only 88 lbs. of dead weight per passenger as compared with 140 lbs., or a difference in favour of the railway over stage coaches of 52 lbs. of dead weight per passenger. But although it is unreasonable to expect passengers to be carried on railways all inside with only the same amount of dead weight as by stage coach, where three-fourths are carried outside, it certainly cannot be thought unreasonable to ask whether passengers cannot be carried by railway with less dead weight than at present; this the writer considers practicable, and further, that every pound of unnecessary dead weight added to any part of a vehicle does not add to its strength, but diminishes it, for being out of proportion to the other parts it is rigid and does not yield uniformly to the strain.

In the writer's opinion, the correct means of saving dead weight is in building the carriages larger, and doing away with unnecessary wheels, axles, axle boxes, springs, &c. For instance, taking an ordinary third class carriage, seating 40 passengers, allowing to each 16 in. of seat room, and weighing 5 tons when empty; this gives 280 lbs. of dead weight per passenger: now the carriage previously named, running on the Oldham branch weighing 6 tons, $11\frac{1}{2}$ cwt., seating 84 passengers, gives 175 lbs. of dead weight per passenger, or a difference of 105 lbs. per passenger in favour of the large carriage. Again, an ordinary modern first class carriage of three compartments, seating 18 passengers, and weighing $5\frac{3}{4}$ tons, gives a dead weight of 715 lbs. per passenger; whilst one of the larger sized first class carriages used on the Lancashire and Yorkshire Railway, 24 ft. long, 7 ft. 6 in. wide, allowing the same room and accommodation as the three compartment carriage, weighing $6\frac{1}{4}$ tons, and seating 24 passengers, gives a dead weight of 583 lbs. per passenger, showing a saving of 132 lbs. per passenger in favour of the long carriage. But if the comparison is made with a first class carriage similar to what is running on the Oldham branch, which is 28 ft. long, 8 ft. 6 in. wide, and 6 ft. high in the clear of the doorway, with five compartments, weighing 7 tons 3 cwt., and seating 40 passengers, this gives a dead weight of only 400 lbs. per passenger. This carriage has the seats divided for four passengers, which, although not so comfortable for long journeys as three divisions is found sufficient for the greater portion of the traffic on most lines.

The writer has lately constructed two carriages to work the Ashton branch of the Lancashire and Yorkshire Railway, shown in Fig. 2, seating 24 first and 120 second and third class passengers, with ample accommodation for guard and luggage. These two carriages with brakes, weighing 16 tons, give better accommodation than the old train, shown in Fig. 1., consisting of six separate carriages, seating 149 passengers, and weighing 30 tons; thereby effecting not only a saving of nearly 14 tons of dead weight per train, but a proportionate saving in first cost nearly equal in amount to the difference in the weight, and also a proportionate saving in wear and tear, both of engines, carriages, and permanent way, and a saving in consumption of coke of 5 lbs. per mile; there is also found to be a saving in time on the journey, as the guard at every station, when going from one end of the train to the other and back, has to walk a distance of only 50 yards with the new train, instead of 88 yards with the old train.

The writer is of opinion that large carriages are very suitable for main lines, but more particularly so for branch lines, and have many advantages over small ones, not only in dead weight and cost of construction and working, but

---

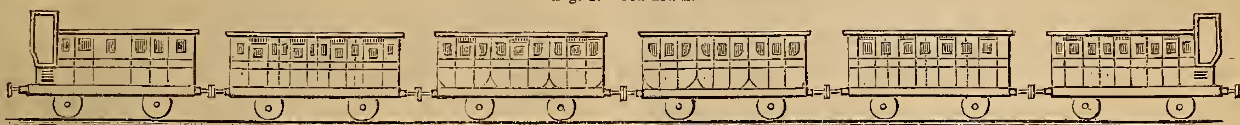
* Paper read before the Institution of Mechanical Engineers.

in having a smaller number of carriage ends; for most passengers, particularly first class, prefer middle compartments, and the old Ashton train, shown in Fig. 1., has twelve carriage ends, whereas the new one has only four. Another advantage is that should any axle break under a short carriage, the chances are it is thrown on its side or turned over; whereas with long carriages in such an accident the carriage is most likely to run as a sledge. A case of this kind occurred on the Lancashire and Yorkshire Railway, near Rochdale, about three years ago, when, during the great snow storm, a train that met with an accident had one of these large carriages attached; the front axle had been broken by the collision at the back of the nave, and the hind wheels were swept entirely away, but the carriage was trailed in this way like a sledge for upwards of a mile, and when the train was brought to a stand it continued parallel to the line of rails. Another advantage of the long carriage is that they run not only freely round the curves, but on straight parts of the line with less lateral motion, and the writer has found the brasses in the axle boxes to wear much less endways than in short carriages. The two carriages before named are 33 ft. long, with the wheels 18 ft. distance of centres; they have been run backwards and forwards with the greatest ease through a curve of less than 200 ft. radius, although six-wheeled engines all coupled cannot pass through; and they run many times daily through a curve at Manchester Station of 330 ft. radius, and the flanges of the tyres do not show any perceptible wear different from that of any ordinary vehicle.

In reference to increase of size of vehicles, it may be remarked by way of illustration that formerly a 500 ton merchant ship was considered a large size, but now nearly as many thousand tons is not uncommon; for as the commerce of the country has increased, instead of building numerous small vessels, the shipwrights have so increased the size of the ships that one will now take as much merchandise as several formerly did, thereby effecting a very great saving. But in the case of railways, as their traffic has increased, have they taken the same view as shipbuilders and increased the size of their vehicles to suit their increased traffic? Not generally, only in some few instances; but they have increased the number of their vehicles and made their locomotives heavier and more powerful to draw the increased weight of carriages, and then as a consequence have had to build their carriages stronger to resist the strain of a longer and heavier train and a more powerful engine, thereby increasing the dead weight in a greater ratio than the increased weight of passengers

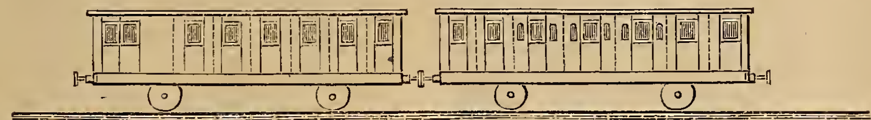
RAILWAY CARRIAGES.

Fig. 1.—Old Train.



Luggage Van.

Fig. 2.—New Train.



Luggage Compartment. Scale, 1-240th.

Fig. 3.—New Carriage, with Luggage Compartments,

Luggage. Luggage.

Fig. 7.—Third Class Carriage.

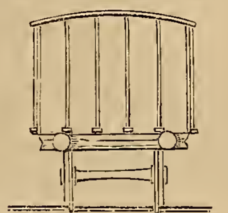
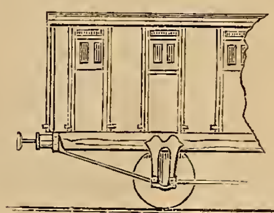
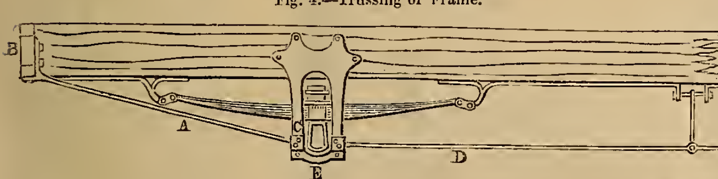


Fig. 8.—Third Class Carriage.



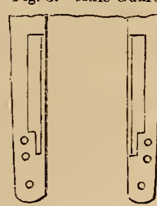
Scale, 1-120th.

Fig. 4.—Trussing of Frame.



Scale, 1-48th.

Fig. 5.—Axle Guard.



Scale, 1-16th.

Fig. 6.

carried. It may be considered an objection to long carriages that, when a train is made up, if there should be a few extra passengers, one of these large carriages would have to be attached; but as mixed trains are now generally run, if the carriages were nearly all composite such a case would seldom if ever occur.

Carrying luggage on the roof the writer considers a very objectionable plan, and can only account for it being continued under the impression that it is the most economical: this however he considers not to be the case; for although a carriage roof cannot be built much lighter when luggage is not carried on it, as it must be made strong enough to bear the weight of a man walking along the top to get at the roof lamps, yet in case of accident a great weight on the roof must act at a serious leverage to damage the carriage, or, if travelling at a high speed, to impart to it a rolling and pitching motion. Many sources of inconvenience to the passengers arise from this plan, such as the difficulty and delay of finding particular luggage at intermediate stations, the annoyance of moving heavy weights over head, and risk of damage from wet; there is also the risk of accident to the men from breaking of the luggage straps in buckling them up, the men having sometimes to strap down the luggage while the train is in motion: these sources of annoyance, inconvenience, and trouble to passengers and to the railway servants are much greater than would be supposed at first. Then the first cost is considerable on lines where much luggage is carried, as nearly every carriage has to be furnished with sheets and straps, though perhaps one-third of them are not used; and the roofs are much impaired by screwing on the numerous laths to protect the roof covering from being cut by the luggage; the cost of keeping up the luggage sheets and straps amounts on a large line to a very great annual sum, caused not only by wear and tear, but by those not regularly used deteriorating much more by lying folded up, as they are liable to mildew and rot, and to being burnt by hot cinders falling on them.

On some lines the luggage is carried to some extent in vans; but although where this can be done it is much preferable to carrying it on the roof, still it has many objections: the van is generally placed in front or at the end of a train, or sometimes at both, and every time the train stops, more especially at a junction, the passengers have either to get out and look after their luggage or run the risk of its not being forthcoming at the journey's end; and at the end, owing to the luggage being all taken out of one place, much inconvenience is caused to the passengers. Where the train has to be broken up this plan cannot be carried out, as a separate van would have to be run with each portion of the train thus separated; so that even when a van is used, the luggage has to a certain extent to be carried on the roof. Some lines have luggage compartments in the centre of the carriage; but this arrangement the writer thinks not the most judicious plan, as it is placing the luggage in the best part of the carriage; and he suggests that luggage vans be entirely dispensed with, and that in place of them every carriage be built with a luggage compartment at each end. He is quite convinced that a first class carriage with three compartments and a luggage compartment at each end, say having a total length of 23 ft. and seating 18 passengers, and not exceeding 6 tons weight when empty could be built at very little additional cost to the present carriages; it would

be stronger and more able to withstand a strain than a similar carriage of the same weight with luggage on the roof; and if the carriage be longer, say 29 ft. and seating 24 passengers, and if wider seating 32 passengers, the difference will be still greater in favour of carriages with luggage compartments. The ends could also be fitted with folding seats to be available for passengers in busy times, seating 10 additional second or third class passengers. The double ends in case of collision would also serve as additional protection to the passengers, the luggage in them acting as extra buffers.

The writer is now building a similar carriage to the last described for the Lancashire and Yorkshire Railway Company, as shown in Fig. 3. It is 29 ft. long, seating 24 passengers, and precisely similar in every other respect to the best modern three-compartment carriages; it will weigh about $6\frac{3}{4}$ tons, giving 630 lbs. of dead weight per passenger, instead of 715 lbs., thereby effecting a saving of 85 lbs. of dead weight per passenger in comparison with the ordinary carriage constructed to carry luggage on the roof. If the carriage be made wider, seating four on each seat, the difference will be still greater. The additional cost of maintaining this extra length will be very trifling; and a saving is effected in first cost equal in proportion to the saving in weight, in addition to the saving in wear and tear of sheets, straps, and roofs of carriages.

Taking another view of the case, suppose a train constructed to carry luggage on the roof to consist of eight ordinary three-compartment first class carriages and a luggage van, each weighing $5\frac{3}{4}$ tons when empty; this train would cost about £2,600, seating 144 passengers, with a total dead weight of $51\frac{3}{4}$ tons. A train of similar carriages, omitting the van, but with luggage compartments at each end, each carriage weighing 6 tons when empty, and allowing $\frac{1}{2}$ ton more for the additional size of the carriage with the guard's compartment, would give a total of $48\frac{1}{2}$ tons, or a saving of $3\frac{1}{4}$ tons in favour of the carriages with luggage compartments. But if the comparison is made with a train of six carriages similar to the one shown in Fig. 3, this train would cost about £2,100, seating 144 passengers, each carriage weighing $6\frac{1}{2}$ tons when empty, and allowing as before $\frac{1}{2}$ ton more for the additional size of carriage with guard's compartment, making a total of $39\frac{1}{2}$ tons; this gives a saving of $12\frac{1}{4}$ tons of dead weight, and of £500 in the first cost, besides the annual saving in wear and tear of sheets and straps, and in busy times the advantage of seating 55 additional second or third class passengers in the luggage compartments.

To prevent the hogging effect of the spring tension bars upon the frame of the carriage, which is subjected to a more severe strain in the long carriages, the writer has adopted a plan which has been found to remove all objections, and at the same time to strengthen the carriage considerably, by trussing the carriage from the end bars of the underframing to the ends of the axle guards, as shown in Fig. 4. The wrought-iron strut, A, $1\frac{1}{2}$ in. diameter in the middle and tapering to $1\frac{1}{4}$ in. at the ends, is secured to the end bar, B, by a flat end and heel bolted to the bar, and the other end of the strut is secured to the axle guard at C, with a double shoulder to take the strain off the bolts. A similar strut D, made stronger in the middle, extends from one axle guard to the other; and in carriages with long centres these middle struts are made of hollow piping to save weight, and are not only tied across to each other, but also to the underframe, and in very long centres diagonal stays are added. The bar E is formed with double shoulders and bolted to the ends of the axle guards to connect the struts.

The axle guards, instead of being made $\frac{3}{4}$ in. thick as usual with the edge working in a groove of the axle box, which is liable to be worn in from $\frac{1}{8}$ to $\frac{3}{8}$ in. after several years' work, have a piece of angle iron rivetted to the legs of the guards, as shown in Figs. 5 and 6, by means of which a face of $2\frac{3}{4}$ in. wide is obtained to work against the axle box. This construction has proved very durable, and some carriages have been at work on this plan six years, and show hardly any wear.

The usual mode of framing coach bodies is by mortice and tenon; but by this method the foot of the pillar, where most strength is required, is weakened, as is also the bottom side into which the mortice is made; and from the wet getting in, the pillar becomes rotted at the foot, the part that requires most strength. In place of this construction the writer has adopted the plan with third class carriages, shown in Figs. 7 and 8, of securing the standing pillars to the bottom sides with corner knees and double clips, retaining the whole strength of the pillar at the foot where it is most required, and not weakening the bottom side with mortices. By thus letting the framing stand prominent one panelling becomes sufficient instead of two, the boarding $\frac{3}{8}$ in. thick being fixed crossways and screwed at the ends into the pillars; this makes a very strong plain body, and without any mortice for the water to lodge in.

It has often been considered that agriculturists were in fault for being slow in adopting improvements; but still they have their ploughing matches, their cattle shows, and trials of implements, and it is well known what extensive improvements have been the result: the writer has often thought that railways might with very great advantage take a lesson from them, and have their shows of rolling stock. It may be said that the gradients of various lines differ so much, that an engine suitable for one line is not suitable for another; but without touching that part of the subject, the writer thinks it will be admitted that, however lines may vary, the passengers do not, and that a good carriage on one line would be so on another. What the writer would suggest is to have a show of rolling stock, say every three or four years, and to let the railway companies contribute to a common fund for the prizes; this would stimulate exertion, and not only lead to improvements, but cause them to be more generally known. If there were a prize to be obtained, every contributor would be anxious for all to see and know his improvements, and would be ready to point out any disadvantages in other vehicles. The result would no doubt be a very great saving, avoiding sometimes very large expenditure in trying over again plans that other companies had already tried and rejected, the result being a mutual advantage to all concerned.

DESCRIPTION OF A NEW HYDRAULIC ENGINE.

By Mr. David Joy, of Leeds.*

The form of hydraulic engine, which is the subject of the present paper, was originated by the requirement of a motive power for the special purpose of blowing the bellows of a large organ, and was not at the time intended to be applied beyond the single case for which it was designed by the writer. Several conditions were requisite in the arrangements: first, that the power should be supplied from some constantly accessible source; this condition at once pointed to water pressure as the only available power, and resolved the question into a hydraulic engine, required not only to give out a reciprocating motion, but to be capable of regulation down to the slowest possible speed without having a deal point; at the same time to be perfectly free from the shocks due to water in motion at high pressure.

The accompanying drawings show the arrangement adopted to meet these conditions. Fig. 1 is a side elevation of the engine, showing the attachment to bellows; Fig. 2 a vertical section through the cylinder; Fig. 3 a vertical section through the valve chest; Fig. 4, a sectional plan.

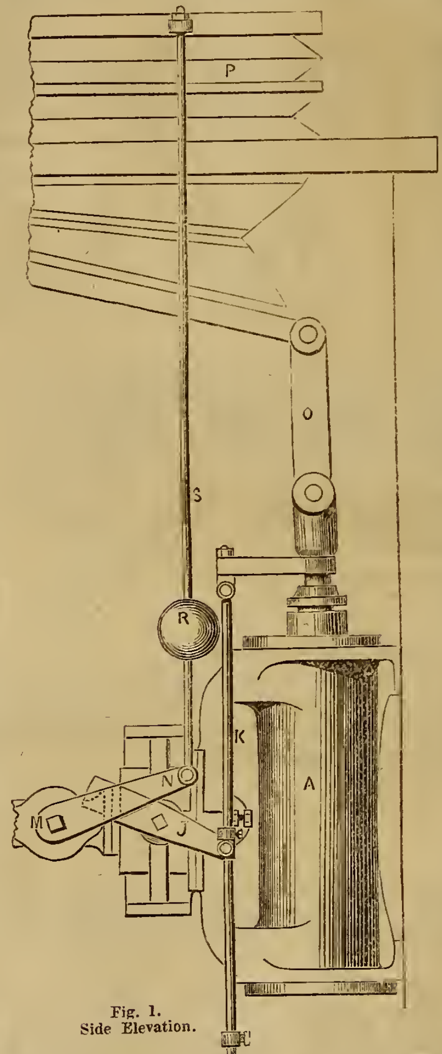


Fig. 1. Side Elevation.

A is the cylinder, with ports the same as in a steam engine cylinder, B B being the inlet ports, and C the exhaust. D is a common slide valve, working over the face of these parts, and moved by its attachment to a small double piston, E E, working in two small cylinders, F F, in the ends of the valve-box, G; H is the water main. The pistons, E E, are moved by the water pressure, which is let into and out of their cylinders alternately by a small four-way cock, I; this four-way cock is moved by a lever, J, and a rod, K, which is attached to an arm on the piston-rod; the rod is fitted with set nuts or tappets for adjusting the action of the four-way cock. In the outlet port of the four-way cock is a setscrew, L, by which the area of passage of that port can be diminished, and the water retarded to any desired extent in its escape from the cylinders, F F, and thus the motion of the valve, D, regulated. O is the attachment to the feeder. On the water-main, H, is a large ordinary stop-cock, M, to which is attached a lever, N, and rod, S, connected with the reservoir of wind, P, at such a position that when the reservoir is full, the cock, M, is closed, and the engine at rest; but when the reservoir descends by the exhausting of the air, the cock, M, is opened by the weight, R, and the engine is set in motion. Fig. 1 shows the normal position of the engine when the water is turned on, and the reservoir full; the engine then moves only at an extremely slow speed, sufficient to supply the leakage of wind through the material of the reservoir. The moment wind is abstracted from the reservoir, its depression opens the cock, M, and the engine is set in motion with a speed proportioned to the amount of the exhaustion. Thus the supply of wind is always in exact proportion to the demand, and overblowing and unsteadiness, as in hand blowing, are entirely prevented.

The peculiarities of the engine are, having a motion of the valve, which can be regulated as to speed, so as perfectly to prevent any shocks from the water at the change of stroke, whatever may be the pressure of the water used; and also a motion of the valve, which can leave no possibility of a dead point, however slowly the engine may be required to work. By reference to the drawings it will be seen that the four-way cock, I, receives a complete motion from the

* Paper read before the Institution of Mechanical Engineers.

piston rod *prior* to the valve, D (upon which the action of the engine depends), having any motion; hence the motion of the valve, D, is ensured *after* the piston has completed its stroke. We have therefore even theoretically an engine moved by a non-elastic fluid, without the assistance of momentum, but without a dead point.

The principles of the engine being settled, and a perfect action obtained, it was still found that the need for greasing the slide valve, though required only once per month, was a detriment; and the next object was to remove even this necessity, and to produce a machine which would require absolutely no attention. Various metals of different degrees of hardness were tried in conjunction;

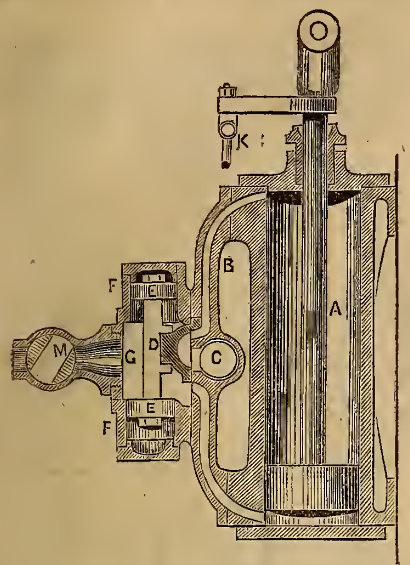


Fig. 2.—Vertical Section.

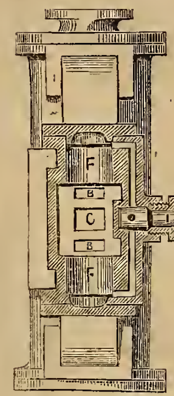


Fig. 3.
Vertical Section through Valve Chest.

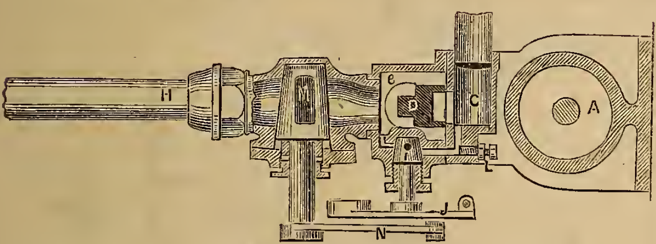


Fig. 4 —Sectional Plan.

also various methods of ensuring the lubrication or moistening of the rubbing surfaces; but the metals were always found ultimately to rub dry, and bite or cut into one another. All this pointed to the necessity for a variety of material in the rubbing surfaces—say metal upon some totally different substance. The paper read before the Institution last year on "Wood Bearings," as applied to the screw shafts of steamers at once suggested wood as the required material; and after two attempts at proportioning the valve, a completely satisfactory result was obtained. Glass was also tried at the suggestion of one of the members of the Institution, but was found to wear much more rapidly than wood. Specimens of the various kinds of valves are exhibited, and an engine sufficiently open to allow of examination of its parts. There is also one at work applied to the large organ at the Art Treasures Exhibition.

The above are only the results of numerous and varied experiments; and it would be impossible here to detail the trains of idea and experiment which led to these results, or individually to acknowledge the assistance rendered by those who have examined the engine or assisted in its construction.

DESCRIPTION OF THE LARGE BLOWING ENGINE AND NEW ROLLING MILL AT DOWLAIS IRON WORKS.*

By MR. WILLIAM MENELAUS, of Dowlais.

(Illustrated by Plate cxx.)

THE large blowing engine and rolling mill forming the subjects of the present Paper are remarkable particularly for their great size, the blowing engine being the largest of its class hitherto erected, either in this country or abroad; and were designed with a view to turning out a large quantity of work with the greatest possible security from risk of failure, or deficiency of the blast, or of breakage of the machinery.

The blowing engine was erected in 1851, and is shown in Figs. 1, 2, and 3, Plate cxx. Fig. 1 is a side elevation of the engine, and Fig. 2 an end elevation. Fig. 3 is an enlarged vertical section of the blowing cylinder.

The blowing cylinder, A, is 144 in. diameter with a stroke of 12 ft., making twenty double strokes per minute; the pressure of the blast being $3\frac{1}{4}$ lbs. per square inch. The discharge pipe, B, is 5 ft. diameter and about 140 yards long, thus answering the purpose of a regulator. The area of the entrance air valves is 56 sq. ft., and of the delivery air valves, 16 sq. ft. The quantity of air discharged at the above pressure is about 44,000 cubic ft. per minute.

The steam cylinder, C, is 55 in. diameter, and has a stroke of 13 ft., with a steam pressure of 60 lbs. per square inch, and working up to 650 H.P. The steam is cut off when the piston has made about one-third of its stroke, by means of a common gridiron valve, D, near the back of the slide valve, E, as shown enlarged in Figs. 4 and 5, Plate cxx.; there is also on one side of the nozzle a small separate slide vale, F, for moving the engine by hand when starting. The cylinder ports are 24 in. wide by 5 in. long, and the slide valve, E, has a stroke of 11 in. with $\frac{1}{2}$-in. lap. The engine is non-condensing, and the steam is discharged into a cylindrical heating tank, 7 ft. diameter and 36 ft. long, containing the feed water from which the boilers are supplied. Under the steam cylinder, C, there are about 75 tons of cast iron framing, G, and 10,000 cubic ft. of limestone walling in large blocks, some of them weighing several tons each.

The beam, H, is cast in two parts of about $16\frac{1}{2}$ tons each, the total weight upon the beam gudgeons being 44 tons; it is 40 ft. 1 in. long from outside centre to outside centre, and is connected to the crank on the flywheel shaft, I, by an oaken connecting rod, K, strengthened from end to end by wrought iron straps. The beam is supported by a wall, L, across the house, 7 ft. thick, built of dressed limestone blocks, to which the pedestals, M, are fastened down by twelve screw bolts of 3 in. diameter. The flywheel, I, is 22 ft. diameter, and weighs about 35 tons.

Eight Cornish boilers are employed to supply the steam, each 42 ft. long and 7 ft. diameter, made of $\frac{9}{16}$-in. best Staffordshire plates, and having from end to end a single 4-ft. tube, in which is the firegrate, 9 ft. long.

For some time this engine supplied blast to 8 furnaces of large size, varying from 16 ft. to 18 ft. across the boshes; it is now blowing, with three other engines of small dimensions, 12 furnaces, some of which make upwards of 235 tons of good forge pig iron per week, the weekly make of the 12 furnaces being about 2,000 tons of forge pig iron. With the exception of the cylinders, made and fitted at the Perran Foundry, Truro, this engine and boilers were made at the Dowlais Iron Works, and erected according to the design, and under the superintendence of Mr. Samuel Truran, the Company's engineer.

The engines for driving the new rolling mill now in course of erection at the same works, are a pair of high pressure engines, coupled at right angles, shown in Figs. 6 and 7, Plate cxx. Fig. 6 is a side elevation, and Fig. 7, an end elevation of the engines. Fig. 11, Plate cxx., is a general plan of the rolling mill to a smaller scale.

The steam cylinder, C, is 45 in. diameter with a stroke of 10 ft., making 24 double strokes per minute. Each cylinder has a common slide valve of brass worked by an eccentric on the main shaft. The expansion valves are of the gridiron sort, worked by a cam on the main shaft, the steam being cut off at about one-third of the stroke; an arrangement is made for throwing these valves out of gear when the engines are doing heavy work. Each engine is furnished with a small slide valve to be worked by hand for the purpose of starting and reversing. The steam is supplied by six Cornish boilers, 44 ft. long and 7 ft. diameter, having a 4-ft. tube in each; the whole of the plates are best Staffordshire, $\frac{9}{16}$-in. thick, and the total weight is 120 tons.

The framing, G, under the engines and machinery, is of cast iron, and consists of four lines, each 75 ft. long, 12 ft. high, and 21 in. wide; the whole weighing about 850 tons.

Each beam, H, is in two parts, the sides weighing about 17 tons, making the total weight of each beam, when complete, about 37 tons. The two beams are supported upon eight columns, L, 24 ft. long and $2\frac{1}{2}$ ft. diameter, securely fastened at the bottom in deep jaws cast upon the framing. Upon the top of each group of four columns is a large and heavy entablature plate, N, which carries the plummer blocks, M, under the main gudgeons. Each column passes through the entablature, the bosses at the junction being 24 in. deep; these are bored and the tops of the columns turned so as to ensure a perfect fit. The plummer blocks, M, are secured by wrought-iron keys in jaws cast on the entablature, N, in the usual manner. The connecting rods, K, are of oak, with wrought-iron straps.

The driving-wheel shaft, I, is of cast iron, with bearings 24 in. diameter; the flywheel shaft, O, is also of cast iron, with bearings, 21 in. diameter. The diameter of the driving wheel is 25 ft. to the pitch line; width on the face, 27 in., and pitch, 7 in. The diameter of the spur wheel or pinion on the flywheel shaft is 6 ft., and the teeth are strengthened by a flange running up to their points on each side. The flywheel, O, on the mill shaft, is 21 ft. diameter, and weighs about 30 tons, making upwards of 100 revolutions per minute. The whole of the fastenings, both of the wheels and framing, are of dry oak and iron wedges, as shown enlarged in Figs. 8, 9, and 10, Plate cxx.

These engines will drive one rail mill capable of turning out 1,000 tons of rails per week, another mill capable of making 700 tons of rails or roughed-down per week, and one bar or roughing-down mill capable of making 200 tons per week; they will thus readily turn out 2,000 tons of iron per week. Two blooming mills, with three high rolls and two hammers, will also be worked by the same engines. The saws and small machinery will be driven by separate engines, as will also the punching and straightening machines.

The roofs cover a space of 240 ft. by 210 ft., and are to be covered with corrugated black plates of No. 14 wire gauge thickness. The span is 50 ft., the roofs being supported upon lattice girders of an average length of 45 ft. The position of the columns is shown on the ground plan, Fig. 11, Plate cxx.; and it will be observed that the entire mill floor is free from obstruction. The flooring will be of cast-iron plates, 1 in. thick.

It has long been felt that the power of rolling wrought iron of large section and great lengths has not kept pace with the requirements of engineers, who are hampered in their designs by the impossibility of obtaining iron of suf-

* Paper read before the Institution of Mechanical Engineers.

ficient dimensions. For engineering works of any magnitude, bars of great length, considerable width, and moderate thickness, are frequently required. In the ordinary mode of rolling, the length and width of the bar are measured by the power of the engine and the time occupied in rolling. It is obvious, that to finish a bar quickly, it is necessary that it should be rolled in two directions to prevent delay: and long and heavy bars can be thus rolled only by an engine of enormous power. This object is designed to be attained by the large combined engines now described. A simple arrangement of rolls for working in two directions, is shown in Figs. 12, 13, and 14, Plate cxx.; the lower pair of rolls, P, is driven from the flywheel shaft; and, under ordinary circumstances, will be worked in the usual manner, rolling the bars in one direction and lifting them over the top roll in coming back. When it is necessary to make extra sized bars, the rolls, R R, will be put in the standards, and driven from the fly-wheel shaft by the pair of wheels, S S, Fig. 6, Plate cxx., thus giving the means of working the iron in both directions, as shown by the arrows. By this arrangement the mill is expected to be able to roll iron of such sections and lengths as have been hitherto unattainable.

DESCRIPTION OF IMPROVED MACHINERY FOR ROUNDING, SURFACING, AND SHAPING WOOD.*

By Mr. Joseph W. Wilson, of Banbury.

The great variety of articles of a cylindrical form which are manufactured in wood, and the inefficiency of the common wood lathe in turning long lengths, the trouble and time required for keeping it in working order, and for fixing and adjusting tools for turning, surfacing or planing wood, led the writer to endeavour to improve the machinery at present employed; and the improvements that he has made, with the results obtained from them, form the subject of the present Paper.

The machine first to be described is the rounding machine, shown in Figs. 1, 2, and 3, which is in use at the Timber Works, Banbury. The timber, A, to be rounded is prepared for the machine by being sawn into a rectangular form of any required length. It is fed through the grooved self-acting weighted rolls, B B, which advance it towards the revolving face-plate, C,

WOOD SHAPING MACHINERY.—Rounding Machine.

Fig. 1.—Side Elevation (part Section.)

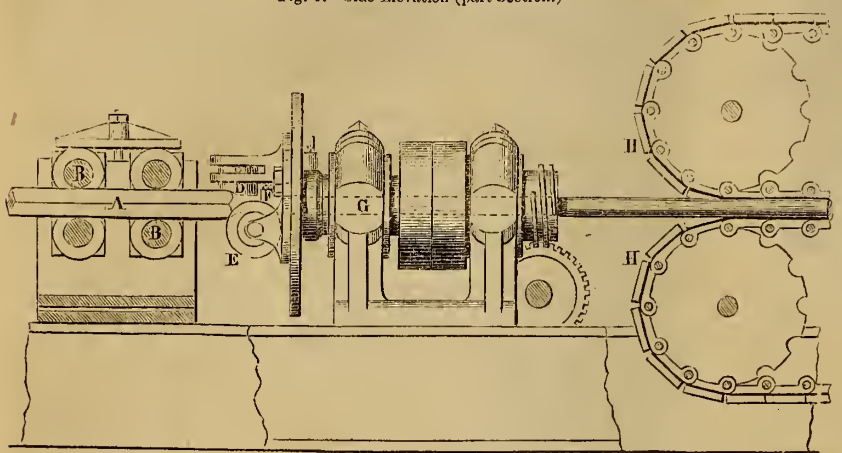


Fig. 2.—End Elevation.

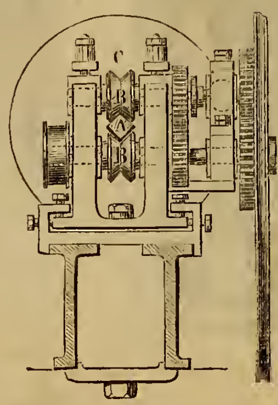


Fig. 3.—Transverse Section.

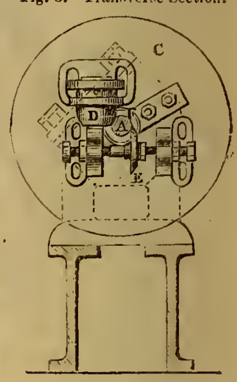


Fig. 4.—Side Elevation of Face Plate.

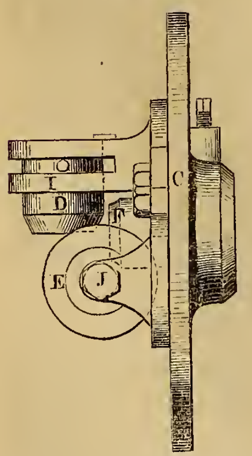
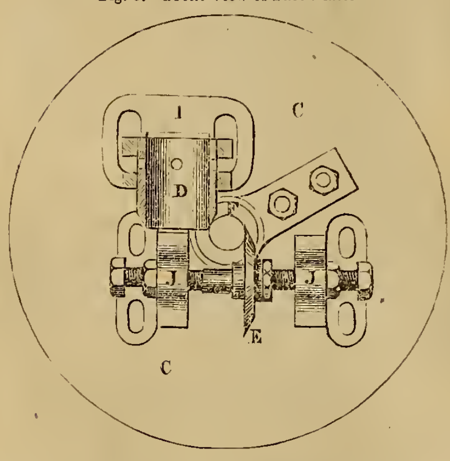
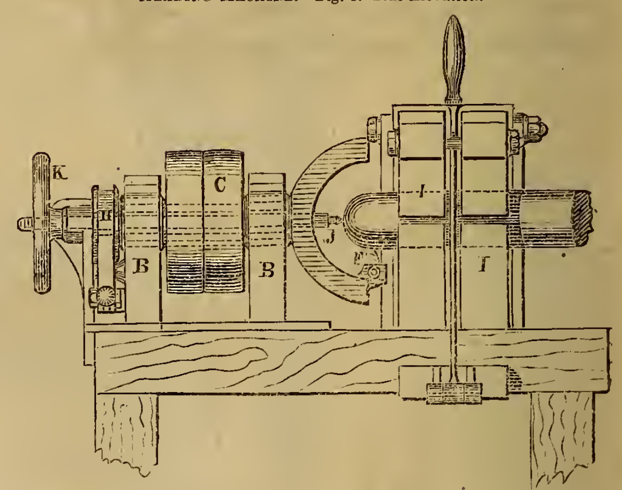


Fig. 5.—Front View of Face Plate.



Heading Machine.—Fig. 6. Side Elevation.



on which the rounding tools, D E, are fixed. When rounded, it passes through the wrought-iron case-hardened die, F, which keeps it perfectly steady for the cut. In this manner it passes through the tubular headstock, G, to which the face-plate, C, is attached, and is then taken between two endless chains, H H, which pass over wheels and rollers, and are impelled in the same direction as the feeding-rollers, B B, and at the same speed. The links of the chains are hollowed out and lined with leather to preserve the finished wood from any impress. The chains are weighted, and are for the double purpose of pulling the tail end of the wood through the die, F, after it leaves the feeding-rolls, B, and keeping it from turning round, which the friction and slight compression during its transit through the die are likely to cause it to do at that time.

In rounding hard woods, the friction in the die is much increased; and the heat thus generated is dispersed in the following manner:—A tubular receptacle constantly supplied with compressed air, the temperature of which is lowered as much as possible, is connected with the rounding machine by a small pipe, and a constant stream of air is allowed to play upon the die; this, by its expansion, absorbs a large amount of heat from the over-heated die.

Figs 4 and 5 are a side elevation and front view enlarged of the face-plate, C, showing the form and position of the rounding tools, which consist of a cylindrical gouge, D, and a paring tool, E, in the shape of a disc of steel with one bevelled edge. At the commencement of the writer's experiments the face-plate was supplied with a set of gouges and chisels of the usual form, lapping over the work as in the ordinary turning of soft woods; by this arrangement only one portion of the edges of the gouges and chisels acted upon the wood, and it was found that after paring 7,680 ft. of circumferential length, or producing only 80 ft. run of rounded wood, they required to be taken out, sharpened, and reset, involving a great waste of time and steel. By the use of the new cylindrical gouge, D, and paring disc, E, these difficulties have been completely obviated by the writer. Figs. 4 and 5 show the position of the tools, and the manner in which they are fixed on the face-plate, C. The gouge, D, which is placed a little in advance of the paring disc, is 2 in. internal diameter, and is sharpened from the outside; it is held in a strong wrought-iron standard, I, which admits of its being turned round at will. The paring disc, E, is fixed on a spindle, supported on the centres, J J, which allow of adjustment. By turn-

* Paper read before the Institution of Mechanical Engineers.

ing these tools round in the slightest degree when the working edge becomes blunt, an entirely new edge is presented to the work, and the whole of their circumference is made available; they will work without being sharpened for 12 or 15 hours. When they require a new edge, they are placed on a spindle

Fig. 7.—Plan.

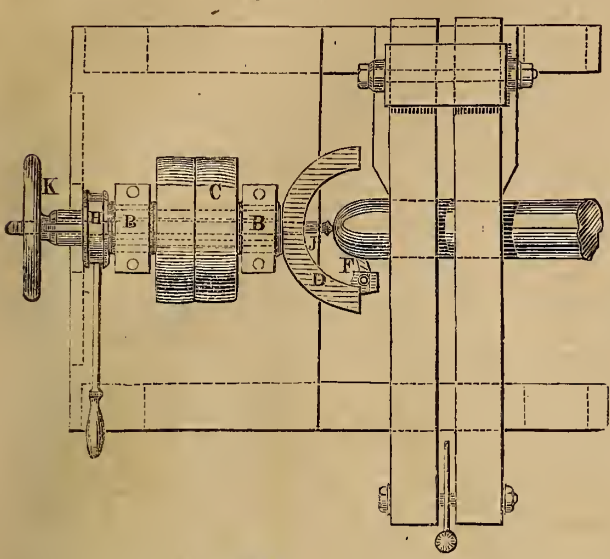


Fig. 8.—Section of Spindle and Guide.

Octagoning Machine.—Fig. 9. Vertical Section.

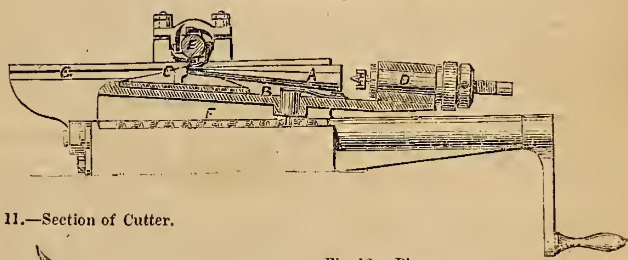


Fig. 10.—Plan.

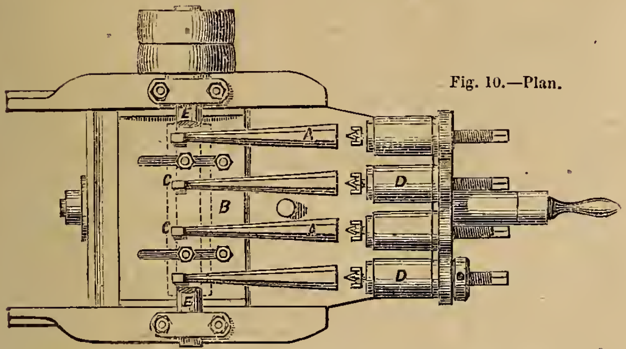
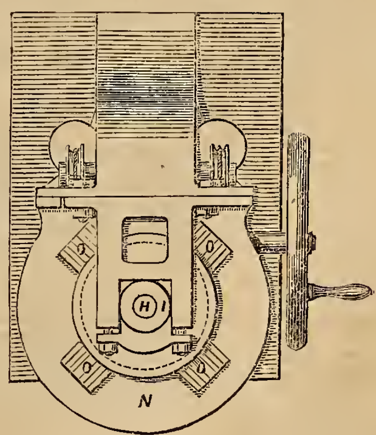


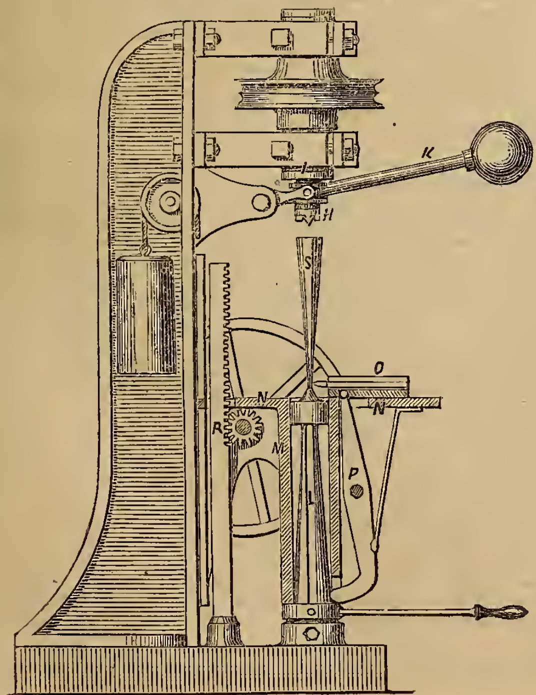
Fig. 11.—Section of Cutter.

Plan.

Fig. 13.—Plan.



Conical Rounding Machine.—Fig. 12. Elevation.



rotating at a high speed, and ground up by stone and oil slip in the ordinary manner.

The headstock of the rounding machine makes about 1,200 revolutions per minute, and the yield of rounded stuff is from 2,000 to 3,000 ft. run in a day of 10 hours. This machine has up to the present time been employed in the manufacture of broom and mop stails, umbrella sticks, &c. Each of the machines produces from 500 to 600 broom stails in 10 hours.

After leaving the rounding machine, the sticks are taken to the heading machine, which imparts a hemispherical form to one end. Figs. 6 and 7 show a side elevation and plan of the heading machine. It consists of a hollow spindle, A, shown enlarged in Fig. 8, revolving in two bearings, B B, driven by a pulley, C, in the ordinary manner. Extending from the end facing the operator is a semicircular guide, D, grooved with adjustable V grooves, like those of an ordinary slide rest, but following the curve of the circle. In these grooves works a sliding quadrant, E, to which is attached a box for holding the foot of the tool, F; at the back of the sliding quadrant, E, is a rack, gearing into a pinion keyed on to a small spindle, G, also hollow, which is fitted into the main spindle, A, of the machine. At the other end of the inner spindle, G, is placed the friction-wheel, H, by tightening which the sliding quadrant, E, is caused to follow the curve of the semicircular guide, D, towards the centre, or outwards, as desired. By the action of springs, the cutter, F, has a tendency to remain as far from the centre of the spindle as possible, or at the extremity of the guide, D. When an amount of friction is applied to the friction-wheel, H, sufficient to overcome the elasticity of the springs, the tool, F, gradually moves towards the centre, describing a quarter of a circle in the guide, D, whilst the whole is rapidly revolving.

The wood to be headed is held in a wooden slip, I, which keeps it perfectly steady. A small mandrel, J, with its front end pointed, passes through the inner spindle, G; this is advanced at pleasure by the wheel, K, acting on a screw, and the front point is placed a little behind the line of motion to be described by the tool. The tool, F, is then fixed at the proper radius from the centre line of the spindle, and the wood to be headed is pushed through the die or clip, I, against the advanced point of the mandrel, J, which assists in its support. As soon as the friction lever is applied to the wheel, H, the tool, F, moves gradually along the guide, D, towards the centre, and completes the heading.

The machine is made to take in any rounded section of wood up to $2\frac{1}{2}$ in. diameter; a boy can head with ease three or four sticks per minute.

An octagoning machine, for giving an octagonal tapered form to pieces of wood of various sizes, is shown in Figs. 9 and 10. Four of the pieces of wood, A A, sawn as nearly the required size and shape as is convenient, are fixed on a sliding plate, B, between a set of steel centres, C C, at one end, and forks fixed in spindles, D D, at the other, the spindles being geared together, so that all can be turned simultaneously by a lever. Four long cutters, of the section shown enlarged in Fig. 11, are fixed on a horizontal transverse shaft, E, and caused to revolve with rapidity transversely across the four pieces of wood, thus taking off the corners of the square, as the plate, B, is advanced by the screw, F, placed underneath. The plate, B, is supported on two pins in a line with the centres of the pieces of wood, working in grooves, G, in the frame; this keeps the smaller end of the tapered wood of a uniform size, while by raising or depressing the other end of the plate, B, by the interposition of different thicknesses of wrought iron to act as ways on which the tail end of the plate may work, the size of the larger end is altered as required. If the ways are irregular or varied in their form, the same variation in form will be imparted to the pieces of wood in the machine. As soon as one face is cut, by causing the spindles to make an eighth of a revolution, another surface is exposed to the cutters. This machine will octagon at the rate of three pieces of wood per minute.

A conical rounding machine, for forming conical pieces of wood, such as handles of painters' brushes, oak trenails for railways, &c., is shown in Figs. 12 and 13. It consists of an upright revolving shaft, H, supplied with a driving-fork, fitted into a hollow spindle, I, with a feather to allow of its being raised or lowered at pleasure by the lever, K. Lower down, but in the same centre line with the shaft, H, is a mandrel, L, turned to the same shape as the required piece of wood. The head of the mandrel, L, is made to fit to a cast-iron cylinder, M, on the top of which is fixed the face-plate, N, carrying slides, O, fitted with cylindrical or other gouges, according to the nature of the work. The gouges are advanced by levers, P, the lower extremities of which press upon the mandrel, L; and the face-plate is raised or lowered by means of the small rack and pinion, R.

The action of the machine is a follows:—The face-plate, N, being lowered, the small end of the wooden cone, S, is placed in a cup at the head of the mandrel, L, and the other fixed on the revolving fork, H. The mandrel is then turned partly round, which allows the ends of the direction levers, P, to slip into grooves formed longitudinally in the mandrel, and causes the tools to open or fly apart. The face-plate is then raised as high as the top of the wooden cone, and the mandrel is turned so as to place the extremities of the lever on its conical surface; and as the face-plate is again lowered, the tools are drawn nearer together, and turn the piece of wood to the desired shape. The revolving spindle, H, is then raised to release the work, and the process is repeated with another piece of wood.

The machines above described have been designed with the object of turning out a large quantity of work with great economy and despatch, by the use of tools that will work through the entire day, without the delay and expense arising from having them constantly sharpened, and requiring the attendance of a mere boy to supply the material and shift the cutters from time to time, so as to bring a fresh portion of the cutting edge into action. The cylindrical gouges and disc paring tools used in the rounding machine are proved by experiment to be applicable to the surfacing or planing as well as the rounding of timber; and it is not unlikely that their use might be advantageous in the working of other materials.

ROYAL INSTITUTION OF GREAT BRITAIN.

January 29, 1858.

Sir Benjamin Collins Brodie, Bart., D.C.L., F.R.S., Vice-President, in the Chair.

William Robert Grove, Esq., Q.C., V.P.R.S.,

ON MOLECULAR IMPRESSIONS BY LIGHT AND ELECTRICITY.

The term *molecule* is used in different senses by different authors: by some it is employed with the same meaning as the word *atom, i.e.*, to signify an ultimate indivisible particle of matter; by others to signify a definite congeries of atoms forming an integral element of matter, somewhat as a brick may be said to be a congeries of particles of sand, but a structural element of a house.

The term is used this evening to signify the particles of bodies smaller than those having a sensible magnitude, or only as a term of contradistinction from masses. If there be any distinctive characteristic of the science of the present century as contrasted with that of former times, it is the progress made in molecular physics, or the successive discoveries which have shown that when ordinary ponderable matter is subjected to the action of what were formerly called the imponderables, the matter is molecularly changed. The remarkable relations existing between the physical structure of matter, and its effect upon heat, light, electricity, magnetism, &c., seems, until the present century, to have attracted little attention: thus, to take the two agents selected for this evening's discourse, Light and Electricity, how manifestly their effects depend upon the molecular structure of the bodies subjected to their influence? Carbon in the form of diamond transmits light but stops electricity. Carbon in the form of coke or graphite, into which the diamond may be transformed by heat, transmits electricity but stops light. All solid bodies which transmit light freely, or are transparent, are non-conductors of electricity, or may be said to be opaque to it; all the best conductors of electricity, as black carbon and the metals, are opaque or non-conductors of light.* Bodies which have a peculiar but definite and symmetrical structure, such as crystals, affect light definitely and in strict relation to their structure: witness the effects of polarized light on crystals: and there are not wanting instances of similar relations between the structure of bodies and their transmission of electricity.

The converse of this class of effects, however, forms more properly the subject of this evening's communication, viz., the changes in the molecular structure of matter produced by Light and Electricity. The effect of light on plants, on their growth and color, the bleaching effects of light on coloured bodies, the phosphorescence of certain substances by insolation or exposure to the sun, have long been known, and yet do not seem to have awakened in the minds of the ancient natural philosophers any notion of the general molecular effects of light. Leonard Euler alone conceived that light may be regarded as a movement or undulation of ordinary matter; and Dr. Young, in answer, stated as a most formidable objection, that if this view were correct, all bodies should possess the properties of solar phosphorus, or should be thrown into a state of molecular vibration by the impact of light, just as a resonant body is thrown into vibration by the impact of sound, and thus give back to the sentient organ an effect similar to that of the original impulse.

In the last edition of his Essay on the "Correlation of Physical Forces," (1855, p. 131), Mr. Grove has made the following remarks on this question: "To the main objection of Dr. Young that all bodies would have the properties of solar phosphorus if light consisted in the undulations of ordinary matter, it may be answered that so many bodies have this property, and with so great variety in its duration, that *non constat* all may not have it, though for a time so short that the eye cannot detect its duration; the fact of the phosphorescence by isolation of a large number of bodies is in itself evidence of the matter of which they are composed being thrown into a state of undulation, or at all events molecularly affected by the impact of light, and is therefore an argument in support of the view to which objection is taken." The above conjecture has been substantially verified by the recent experiments of M. Niepce de St. Victor, of which the following is a short *résumé*:—

An engraving, which has been for some time in the dark, is exposed to sunlight as to one half, the other half being covered by an opaque screen: it is then taken into a dark room, the screen removed, and the whole surface placed in close proximity to a sheet of highly sensitive photographic paper. The portion upon which the light has impinged is reproduced on the photographic paper, while no effect is produced by the portion which had been screened from light. White bodies produce the greatest effect, black little or none, and colours intermediate effects.

An engraving exposed as before, then placed in the dark upon white paper, conveys the impression to the latter, which will in its turn impress photographic paper.

Paper, in a tin case, exposed to sunlight, then covered up by a tin cover will, when opened in the dark, radiate from the aperture phosphorescent force, and produce a circular mark on the photographic paper, and even impress on the latter the lines of an engraving interposed between it and the photographic surface.

Phosphorescent bodies produce similar effects in a greater degree, and bodies which intercept the phosphorescent effect intercept the invisible radiations. A design drawn by a fluorescent substance, such as a solution of sulphate of quinine on paper, is reproduced, the design being more strongly impressed than the residual parts of the paper.

Mr. Grove had little doubt that had the discourse been given in the summer instead of mid-winter, he could have literally realised in this theatre the Lagado problem of extracting sunbeams from cucumbers!

While fishing in the autumn, in the grounds of M. Seguin, at Fontenay, Mr. Grove observed some white patches on the skin of a trout, which he was satisfied had not been there when the fish was taken out of the water. The fish having been rolling about in some leaves at the foot of a tree, gave him the notion that the effect might be photographic, arising from the sunlight having darkened the uncovered, but not the covered portions of the skin. With a fresh fish a serrated leaf was placed on each side, and the fish laid down so that the one side should be exposed, the other sheltered from light: after an hour or so the fish was examined, and a well defined image of the leaf was apparent on the upper or exposed side but none on the under or sheltered side. There was no opportunity of further experiment; but there seems little doubt of the effect being photographic, or an oxidation or deoxidation of the tissue determined by light.

Many important considerations might be suggested as deducible from the above results, as to the influence of light on health, both that of vegetables and animals. The effect of light on the healthy growth of plants is well known; and it is generally believed that dark rooms, though well heated and ventilated, are more "close" or less healthy than those exposed to light. When we consider the invisible phosphorescence which must radiate from the walls and furniture, when we consider the effects of light on animal tissue, and the probable ozonizing or other minute chemical changes in the atmosphere effected by light, it becomes probable that it is far more immediately influential on the health of the animate world than is generally believed.

The number of substances proved to be molecularly affected by light is so rapidly increasing, that it is by no means unreasonable to suppose that all bodies are in a greater or less degree changed by its impact.

Passing now to the effects of Electricity, every day brings us fresh evidence of the molecular changes effected by this agent. The electric discharge alters

* It should be borne in mind that these terms are not absolute, but only express a high degree of approximation.

the constitution of many gases across which it is passed; and it was shown, that by passing it through an attenuated atmosphere of the vapours of phosphorus, this element is changed by the electric discharge into its allotropic variety, which is deposited in notable quantity on the sides of the receiver. In this experiment, the transverse bands or striæ discovered by Mr. Grove, in 1852, are very strikingly shown. Not only is the gaseous intermedium thus affected, but the terminals from which the discharge appears to issue are disintegrated, and their molecules projected. Some tubes, through the interior of which Mr. Gassiot had passed the discharge from Ruhmkorff's coil for a considerable time, were shown to be coated in the interior, for a notable space around the negative terminal, with a deposit of platinum, forming a reflecting surface like the back of a looking glass. The vacuum in these tubes was Torricellian, the tubes having been hermetically sealed after the descent of the mercury, so as to cut them off from the mercurial surface. In these cases the electric discharge passes from metal to metal; but the glow which is seen on excited electrics, such as glass, was also shown by Mr. Grove to be accompanied with molecular change. Letters cut in paper, and placed between two well-cleaned sheets of glass, formed into a Leyden apparatus by sheets of tin foil on their outer surfaces, and then electrified by connexion for a few seconds with a Ruhmkorff coil, had invisible images of the letters impressed upon the interior surfaces, which were rendered visible by breathing on them; and rendered visible, and at the same time permanently etched, by exposure, after electrization, to the vapour of hydrofluoric acid.

So, again, if iodized collodion be poured over the surface of glass having the invisible image, and then treated as for a photograph, and exposed to uniform daylight, the invisible image is ultimately developed in the collodion film; the invisible molecular change having been conveyed to the collodion, and rendering it, when nitrated, more sensitive to light in the parts where it has been in proximity to the electrical impression, than in the residual parts. Here we have a molecular change, produced first by electricity on the glass, then communicated by the glass to the collodion, then changed in character by light, and all this time invisible; and then rendered visible by pyrogallic acid, the developing chemical agent. Test papers between the plates of glass so electrized, show an acid, and also a bleaching re-action, probably due to the formation of nitrous acid and of ozone; and thus evidencing a chemical change in the elastic intermedium, as well as in the bounding surfaces: but the interior molecules of the glass appear also to partake of the effect, as the impressions are reproduced in many cases on the opposite surface of the glass.

Mr. Babbage had observed that some plates of glass which had formed the ornamented margin of an old looking-glass, and were backed by a design in gold leaf covered with plaster of Paris, showed, when this backing was removed by soft soap, an impression of the gold leaf device, which was rendered visible by the breath on the glass. Some of the plates had been kindly lent by him for this evening; and, in one, Mr. Grove had removed a portion of the backing, and the continuation of the gilded design came beautifully out by breathing on the glass while in the frame of the electric lamp, and was projected (as were the previous electrical images) on a white screen. The effect on Mr. Babbage's plates may be also electrical, arising from the gold—a good conductor—acting as platinum does in the voltaic battery, and setting up a chemical action between the substance used for making the gold adhere and the glass, or between the constituents of the glass itself; but it would be hazardous, without further experiment, to express any confident opinion on this point.

Of the practical results to science of the molecular changes forming the subject of this evening's discourse, a beautiful illustration was afforded by the photographs of the moon by Mr. Warren De la Rue, which gave, by the aid of the electric lamp, images of the moon of six feet diameter, in which the details of the moon's surface were well defined,—the cone in Tycho, the double cone in Copernicus, and even the ridge of Aristarchus, could be detected. The bright lines, radiating from the mountains, were clear and distinct. A photograph of the planet Jupiter was also shown, in which the belts were very well marked, and the satellites visible. The following question was suggested by Mr. Grove. As telescopic power is known to be limited by the area of the speculum or object glass, even assuming perfect definition, as the light decreases inversely as the square of the magnifying power, a limit must be reached at which the minute details of an object become lost for want of light. Now, assuming a high degree of perfection in astronomical photographs, these may be illuminated to an indefinite degree of brilliancy by adventitious light. With a given telescope, could a better effect be obtained by illuminating the photographic image, and applying microscopic power to that, than by magnifying the luminous image in the usual way by the eye-glass of the telescope? Can the addition of extraneous light to the photograph permit a higher magnifying power to be used with effect than that which can be used to look at the image which makes the photographic impression? In other words, is the photograpic eye more sensitive than the living eye; or can a photographic recipient be found which will register impressions which the living eye does not detect, but which, by increased light or by developing agents, may be rendered visible to the living eye? Much may be said, *pro* and *con*, on this question, and it probably can only be satisfactorily answered by experiment, when photographic science is sufficiently advanced.

The phenomena treated of this evening, which are a mere selection from a crowd of analogous effects, show that light and electricity, in numerous cases, produce a molecular change in ponderable matter affected by them. The modifications of the supposed imponderables themselves have long been the subjects of investigation; the recent progress of science teaches us to look for reciprocal effects on the matter affected by them.

Gases which have transmitted *light* are altered; as, for example, chlorine is rendered capable of combining directly with hydrogen; liquids are altered, peroxalate of iron is chemically changed, and gives off carbonic acid; and the light which has produced these effects is less able to produce them a second time. Solids are altered, as shown in the extensive range of photographic effects. So with *electricity*,—compound gases are changed chemically, as ammonia or atmospheric air; elementary gases are changed allotropically, as phosphorus vapour, or oxygen; liquids are changed, as in the decomposition of water and other electrolytes; and solids are changed, as in the projection of the particles of the terminals, and the impressions on the surfaces of electrics, shown this evening. Few, indeed, if any, electrical effects, have not been proved to be accompanied with molecular changes; and we are daily receiving additions to those produced by light. So, again, iron and other bodies have their molecular structure changed by magnetism. Chemical affinity is universally, and heat generally, admitted to be an affection of ordinary matter. Mr. Grove feels deeply convinced that a dynamic theory, one which regards the imponderables as forces acting upon ordinary matter in different states of density, or as modes of motion, and not as fluids or entities, is the truest conception which the mind can form of these agents; but to those who are not willing to go so far, the ever-increasing number of instances of such molecular changes affords a boundless field of promise for future investigation, for new physical discoveries and new practical applications.

The permanency of such changes also gives valuable means of reading, in the present state of matter, its past history; final or absolute knowledge on such subjects we cannot hope to obtain, but relative or approximate knowledge is as unlimited as is the degree of improvement in the powers attainable for its acquisition.

CORRESPONDENCE.

WAVE-LINE SYSTEM OF SHIPBUILDING.

To the Editor of The Artizan.

Sir,—Having read several articles in The Artizan on the "Wave-line system of Shipbuilding," I beg to add a few suggestions on the wave-line and hollow-bowed vessels in general.

Now, I believe it to be generally acknowledged by naval architects, with the exception of Mr. Armstrong, and some few, that to acquire speed in steam-vessels, it is necessary to have a good length of bow, with a proportionate length of run aft, and a small area of midship section, and power in proportion to the Speed required.

By having hollow load-lines in the bow and stern, as is the case with the *Leviathan*, and more particularly so with Mr. Scott Russell's *Victoria* and *Adelaide* (vessels belonging to the Australian Steam Navigation Company), it is necessary to increase the area and length of the midship section (*and by so doing greatly increase the friction*), and shorten the bow and stern, to get the required amount of displacement. Now, from this simple fact, it appears evident to me that a straight bow, or, at all events, one only slightly hollow at the extreme entrance (*which I believe to be preferable*), is the best adapted for speed.

In the annexed diagram the straight bow is indicated by the solid, and the wave by the dotted, line.

Having met with those who are of a different opinion, I am desirous of laying my view of the matter before the readers of The Artizan, with a view of entering into a discussion on the subject, as being one of interest and of immense utility to the shipbuilding profession; for at present shipbuilders have such various opinions, and many of them far beyond the limits of all reason.

I am, Sir, your's truly,

T. Smith, Naval Architect.

FAIRBAIN'S EXPERIMENTS ON BOX AND PLATE BEAMS.

To the Editor of The Artizan.

Sir,—I have read with some interest the letter of your correspondent "U." in The Artizan for February, and recognise in it a valuable *résumé* of Mr. Fairbairn's experiments on Box and Plate beams. Nothing can exhibit more clearly than this letter the utter inadequacy of these experiments to furnish proper data for calculating the strength of wrought iron in either form.

According to your correspondent's own showing, the sole experiment on box beams which gave a coefficient exceeding 2, was one numbered 5 and 25, in which the tube was only 1 in. wide and 8 in. deep, the proportions of top and bottom flange being as 100 : 162. An experiment on the model tube 75 ft. long, in which the proportions of top and bottom were totally different; namely, as 100 : 107, gave, according to him, a coefficient of 2·18, and from these two experiments it seems to me that your correspondent boldly ventures to deduce a coefficient of 2 for all tubular girders. I can only repeat, Sir, that in my opinion these experiments are not sufficient to satisfy any careful, candid inquirer, nor to produce confidence in the use of tubular wrought-iron girders.

Your correspondent appears to be most delicately sensitive on the subject of Mr. Fairbairn's reputation for accuracy, but he seems to overlook entirely the wide difference between Mr. Fairbairn and himself. According to your correspondent, the coefficient for small wrought-iron plate beams, unsupported laterally, is 1·5, which I have already abundantly shown is the very same coefficient as Mr. Fairbairn himself has established for cast-iron flanged girders of the Hodgkinson form. *Hence a wrought-iron plate girder and a cast-iron Hodgkinson girder, to support the same weight, ought to have equal areas, and ought to weigh very nearly the same*; but if your correspondent

will refer to Mr. Fairbairn's book on the application of cast and wrought-iron (edition 1854, page 78), he will find him calculating that a wrought-iron plate beam, to support $27\frac{1}{2}$ tons in the middle, would weigh only 16 cwt., whereas a cast-iron Hodgkinson beam to support the same weight must weigh 40 cwt., or $2\frac{1}{2}$ times as much! How can this be, if 1·5 is to be the coefficient for both kinds of beam?

I could point out many more inconsistencies between your correspondent and Mr. Fairbairn, but I refrain from doing so, as I am satisfied with having directed attention to the fact that our knowledge is by no means perfect on the subject of wrought-iron beams; nothing like so perfect, for example, as that which we possess with reference to cast-iron—thanks to the valuable labours of Mr. Fairbairn and Mr. Eaton Hodgkinson.

Your correspondent draws a comparison with Mr. Fairbairn's experiments on flanged cast-iron beams, in order to show that the experiments on wrought-iron were as satisfactory as the former; but I cannot at all agree with his conclusions in this matter.

For example, he states the following coefficients for the wrought-iron box beams, as derived from the only two experiments which need be considered; namely

From experiment 5	28·6
„ „ 6	17·8
Mean	23·2

Now, as these experiments differ according to your correspondent's own figures more than 50 per cent., he surely cannot himself allege that they are satisfactory.

But the coefficients for the cast-iron beams, using of course only those in which the beam had the proper proportions, were far more uniform and consistent.

Thus the coefficient for flanges as 1 : 6, was	1·597
„ „ 1 : 6·73	1·402
„ „ 1 : 6·72	1·522
Mean	1·507

or, in round numbers, the mean is 1·5. I think it will now be seen that these experiments are *a little* more satisfactory than those on wrought iron.

The last coefficients quoted by your correspondent are useful and suggestive. He makes the coefficient for small plate beams, unsupported laterally, actually no greater than for the best form of Hodgkinson beam in cast iron, whilst in the very strongest form into which human ingenuity has yet been able to fashion wrought iron, its strength is only one-third more than that of the best form in cast iron. Are these to be considered satisfactory results, and am I not justified in saying that our knowledge is still very imperfect as to the comparative strength of wrought and cast iron?

And now, Sir, let me assure the readers of THE ARTIZAN, and your correspondent in particular, that I yield to none in admiration of Mr. Fairbairn; and that no one can appreciate more highly than I do the valuable services which he has rendered to engineering science and to the commercial enterprise of the present day, by his excellent and practical researches into the strength of iron; at the same time the experiments of Mr. Fairbairn are public property—to be used and applied for public and highly important purposes—and I have only been performing a proper and legitimate duty in calling attention to particulars in which I consider them defective. In fact, the importance of the subject, and the serious consequences which would follow any error, must form a sufficient apology for doing so.

As to the more immediately personal observations relating to myself in your correspondent's letter, I am not aware that they require any reply or comment from me. A small error which he refers to in one of my calculations is so obscurely alluded to, that I have not been able to find it out, but shall be happy to correct it if I come across it in a future revision. In conclusion, I am glad to see that "U" appears to recognise the propriety of my proposal to use a coefficient which applies to the *whole area* of the girder, instead of the bottom flange only.

I am, Sir,
Your very obedient servant,
SAMUEL HUGHES.

14, *Park Street, Westminster, S.W.*,
February, 1858.

STEAM SHIP CAPABILITY.

To the Editor of The Artizan.

SIR,—The practical application and utility of various papers on "Steam Ship Capability," which have appeared in THE ARTIZAN, have been very fairly challenged, by being put to the test of approximately determining beforehand what will be the speed and capability for sea service of that unprecedented vessel the *Leviathan*, now afloat, and expected in a few months to commence her career. Speculative opinion has been rife on this subject. The type of build of the *Leviathan* is said to be that of the Wave Line system, which is asserted by some to be so peculiarly adapted for easy propulsion, that even 25 knots per hour has been quoted as the probable speed of the *Leviathan* when propelled by the maximum power which her engines of 2,600 nominal H.P. may be expected to develop; and as to the capability of the *Leviathan* for sea service, it has been affirmed that this ship, propelled at the speed of 15 knots per hour, will be capable of making the passage from England to Calcutta and back without re-coaling abroad, thus obviating the extra cost of coaling at a foreign station. I have had some experience of what is termed the Wave Line type, but I am not aware of any realised statistical data of steam-ship performance on which the above-mentioned assumptions as to the probable capability of the *Leviathan* can be based. Truly, in this age of remarkable events in practical science, no man can presume to limit the yet unknown eventualities of the future; but still it is admissible for any man to question published statements, especially if mysterious, and advance counter statements, the results of calculations based on the data of already-realised practice: and it is on these grounds that I now venture to present to your readers the following tabular statement as to what, in my opinion, may be expected to be the steaming capabilities of a vessel of the reputed size of the *Leviathan*, if put to work by the agency of appliances already known and already in operation with ascertained effect. My object in this procedure is not to advance a mere speculation as to the probable speed of the vessel in question, but to verify or refute the system of calculation which I have been instrumental in putting forward as a system of mercantile arithmetic, whereby the dimensions and engine power of steam-ships may be systematically adapted to the requirements of any special service:—

TABLE, *showing the Speed in Nautical Miles per Hour that may be expected to be realised by a Steam-ship, having Displacement corresponding to Draft as shown herein, the Vessel being propelled by Steam alone of the gradation of power shown in the respective Columns, and the Type of form of the Vessel being assumed such that the coefficient* (C) *of Dynamic merit resulting from the formula* $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C$, *will be* 215·5; *which coefficient is said to be now commonly realised by Mercantile Steamers.*

Indicated H.P.		1000	1500	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
Coals per Day .... Tons		37·5	56	75	112·5	150	187·5	225	262·5	300	337·5	375	412·5	450
Draft. Feet.	Displacement. Tons.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.	N. M.
20	17,000	6·88	7·88	8·67	9·93	10·92	11·77	12·51	13·16	13·76	14·32	14·83	15·31	15·76
21	18,010	6·79	7·77	8·56	9·80	10·79	11·62	12·35	13·00	13·59	14·13	14·64	15·11	15·55
22	19,040	6·71	7·68	8·46	9·68	10·65	11·47	12·19	12·84	13·42	13·96	14·46	14·92	15·36
23	20,090	6·63	7·59	8·35	9·56	10·53	11·34	12·05	12·69	13·26	13·79	14·29	14·75	15·18
24	21,160	6·55	7·50	8·26	9·45	10·41	11·21	11·91	12·54	13·11	13·63	14·12	14·58	15·01
25	22,250	6·48	7·42	8·23	9·35	10·29	11·08	11·78	12·40	12·96	13·48	13·97	14·42	14·84
26	23,360	6·41	7·34	8·08	9·25	10·18	10·96	11·65	12·27	12·83	13·34	13·82	14·26	14·68
27	24,490	6·34	7·26	8·00	9·15	10·07	10·85	11·53	12·14	12·69	13·20	13·67	14·11	14·53
28	25,640	6·28	7·19	7·91	9·06	9·97	10·74	11·41	12·02	12·56	13·07	13·53	13·97	14·38
29	26,810	6·22	7·12	7·84	8·97	9·87	10·63	11·30	11·90	12·44	12·94	13·40	13·83	14·24
30	28,000	6·16	7·05	7·76	8·88	9·78	10·53	11·19	11·78	12·32	12·81	13·27	13·70	14·10

By the foregoing Table, it is assumed that the engines, singly or collectively, will be capable of developing any amount of power that may be required from 1,000 up to 12,000 indicated H.P.; that the consumption of coals will be at the rate of $3\frac{1}{2}$ lbs. per indicated H.P. per hour, or $37\frac{1}{2}$ tons per day per 1,009 indicated H.P.; and that the displacement of the vessel will be 17,000 tons at 20 ft. draft, progressively increasing up to 28,000 tons at 30 ft. draft. Also, in the foregoing calculation, no notice has been taken of the effect of the wind; but assuming that at 22,250 tons displacement the vessel would sail, without the aid of steam, at the average rate of $6\frac{1}{2}$ knots per hour, the wind would thus give a power represented by 1,000 indicated H.P., which amount of sailing power would scarcely give any appreciable increase of speed when the vessel is steaming at the high rate of 13, 14, and 15 knots per hour. In fact, it appears probable that a high speed steam service, say above 12 knots per hour, is, on the general average of sea service, retarded rather than accelerated by the action of the wind.

Now, in the first place, it may be observed, that the increase of displacement (11,000 tons) from the 20 ft. draft to the 30 ft. draft, causes a reduction of speed of only about $10\frac{1}{2}$ per cent. Hence, with a given amount of working power, or with any given consumption of fuel per hour, the speed at sea during one voyage may be expected to be very nearly uniform, the extremes being within 5 per cent. of the mean, or but very little affected by the difference of displacement caused by the consumption of fuel; and the difference of average speed that may be

observed between any two voyages, when working with a given amount of power, will afford some indication of the amount of loss that may be occasioned by foulness of bottom. For example, if on one voyage the speed attained by 10,000 indicated H.P. be 14 knots per hour, with a draft of say 25 ft., and on the succeeding voyage it be only 13 knots, with the same draft, the detriment from such cause will be about equivalent to 2,000 indicated H.P., or an additional 2,000 indicated H.P. would be required to attain the 14 knot speed. Further, as respects distance without re-coaling, assuming the quantity of coals taken on board to be 11,000 tons, being the entire displacement between the 20 and 30 ft. immersion, and the mean draft to be 25 ft., it appears that by working up to 10,000 indicated H.P., consuming probably 375 tons of coal per day, the speed attained would be 13·97, say 14 knots per hour, the coals would last 30 days, and the distance steamed would be 10,000 nautical miles; but if the working power be reduced to 7,000 indicated H.P., the speed may be expected to be 12·40 knots per hour, the consumption of coals would then be probably 262½ tons per day, lasting 42 days, and the distance steamed would be 12,500 nautical miles, being about the distance from England to Calcutta. At the mean draught of 24 ft., with a mean displacement of 21,160 tons, and the engines working up to 12,000 indicated H.P., the average speed of 15 knots would probably be attained, and the vessel may be expected to make a passage of 2,880 nautical miles in eight days. As regards the speed of 25 knots per hour being attained by a vessel of the mean displacement of 22,250 tons, propelled by engines working up to 12,000 indicated H.P., this performance would demand, by the formula above referred to, that the coefficient of dynamic merit should be no less than 1,050; whilst the best of modern ships produces by the rule referred to, a coefficient of only about 250. To believe that such an improvement will be all at once produced by any peculiarity in the type of form of the *Leviathan*, demands a power of credulity which I must confess that I do not possess.

The future comparison of this table, with the speeds that may be actually realised by the *Leviathan* under the various conditions of displacement and indicated H.P. embraced by the table, will practically demonstrate the soundness or fallacy of the principles on which this system of steam-ship arithmetic is based, viz., that under all variations of power (the displacement and effective condition of the vessel and engines being constant), the cube of the speed multiplied by the cube root of the square of the displacement, and the product divided by the indicated H.P. (or by the consumption of fuel in a given time, if it be in any constant ratio to the indicated H.P.) will produce a constant number or coefficient indicative of the dynamic merit of the ship; and should this theory be approximately confirmed, we shall then have the means of definitely comparing, by the coefficients thus deduced, the intrinsic dynamic merits of different types of ships, and estimating their capabilities as respects their adaptation to all the various requirements of Mercantile Steam Transport Service.

I am, Sir,
Yours, very obediently,
CHARLES ATHERTON.

Royal Dockyard, Woolwich,
18th February, 1858.

REVIEWS AND NOTICES OF BOOKS, March, 1858.

[We regret that several of the following Reviews and Notices of Books were obliged to stand over until now, for want of space.]

The Engineer's and Contractor's Pocket Book for the year 1858. John Weale, London.

This valuable pocket book of reference for engineers and contractors has received a fair amount of revision and additions; for, besides having a list of the officers and members of the Institution of Civil Engineers corrected to December 31, 1857, we observe a number of short papers upon various subjects of interest have been added; these are interspersed throughout the work. Previous to 1857, Mr. Weale had published his pocket book with the almanack and memoranda portions, together with the calendars for two years; in the present volume we are glad to see that he has confined this portion of the work to one year only, which is, in our opinion, a considerable improvement, the book being less bulky, and may be more correctly designated a pocket book. The high reputation which Weale's Pocket Book has obtained amongst engineers, renders it a work of supererogation to do more than remind our readers of its publication for 1858.

Projectile Weapons of War and Explosive Compounds. By J. Scoffern, M.B. Third Edition, pp. 306. Longmans, London.

This, the third edition of a valuable and well-known work of reference, which is to be found in the hands of every intelligent military officer and in all military libraries, has been dedicated by the author to the officers of the United States frigate *Merrimack*, as a compliment to them in acknowledgment of their hospitality and courteous reception extended by them to Dr. Scoffern, whilst making a scientific visit of inspection, to which reference is made in the volume.

The first edition of this book was published about twelve years ago; and it is a curious circumstance, which the author in his preface to the second edition relates respecting it, "that immediately on its being announced for publication, the whole stock, with the exception of about a dozen copies, was purchased by the agent of a foreign state, and exported;" how jealous must authors be of such a success, and who amongst them, does not wish such a fate may await the results of his literary labours; and what an amount of satisfaction it would afford to many a publisher of scientific books if he could but ensure a similar result for whatever might pass through his press; and if a foreknowledge of such an event being certain could only be acquired, how vastly would the number of copies worked off be increased; seriously, however, this is not the common fate reserved for ordinary works.

The author has divided his work into twenty-two chapters, or divisions, the first being a history of the early implements of war; next, a description of ancient artillery; then, a scientific dissertation on projectile forces, describing tranquil and explosive combustion; a history of the invention of gunpowder, and a description of various explosive compounds; a short treatise on the application of gunpowder for military purposes; a descriptive chapter devoted to artillery projectiles; a long and interesting chapter on war rockets; a very short, but useful, chapter on gunpowder applied to military mining; a brief historical sketch of the employment of small fire arms; another short chapter is devoted to the consideration of the variety of small arms employed at various times for war purposes, which, however, brings down the history of such military weapons only to 1853, and then refers to the practice with Minnié rifle muskets. Polar projectiles and "Polar weapons" are next treated of in an able and scientific manner, in a short chapter devoted to their consideration; and the author, after defining the term polarity, as applied in the consideration of the subject under treatment, describes the shells used a few days ago in the attempt on the life of the Emperor of the French, as polar percussion shells. He says—"The shells exploded near the carriage of the French Emperor, January 14th, 1858, were 'polar percussion shells,' polarity being determined by making one end of the shell heavier than the other. They appear to have been made of cast steel, lathe turned; to have been cylindrical in the middle, each having two truncated conoidal extremities. The extremity of impact of each is screwed into the body; the other extremity being slid in. Explosion was determined by twenty-five nipples, each primed with a percussion cap. The charge is said to have been fulminate of mercury. Such a missile would be inapplicable in a military sense."

Thus it will be seen that the most novel of this class of missile has been described by the author.

The chapter devoted to rifle guns describe the want of accuracy common to the flight of projectiles from smooth bore musket barrels, when the ordinary spherical bullet is employed; the advantages of rifling are described; the almost unvarying certainty or accuracy of the flight of elongated bullets from properly rifled barrels is insisted upon; and the necessary conditions to be observed in rifling the bore, and in proportioning the elongated bullet or projectile, are carefully considered. This chapter also treats of the use of the ordinary rifle with conoidal projectiles, which, the author informs us, the Americans have styled "*pickets.*" He then proceeds, under the heading of the developments of the rifle gun, to notice Mr. Whitworth's labours, of which we regret to find the author does not appear to entertain any very high opinion; and after noticing the Lancaster oval bore rifle, to which he devotes brief consideration, he treats of the inconvenience of muzzle loading rifles, and of the application of the expansive principle to such arms; and after describing the various descriptions of bullets and small arms used in the British service in 1854, and the practical merits of each, he proceeds to describe the breech-loading principle and its application to various arms, and he sub-divides them into—first, the slide; second, the hinge; third, the screw and trap-door; and fourth, the revolver system. In speaking of Colonel Green's cavalry carbine, under the first head, he says it is "as near a perfect weapon as can be imagined;" but with this opinion we entirely disagree. Under the second head is classed Sharp's American carbine, and describes the disadvantages of this weapon; in these objections we entirely concur; and as we know there is no absolute necessity for biting off or cutting off the ends of cartridges, nor for the introduction of any mechanical contrivance for puncturing, or for producing ignition by percussion within the cartridge, we have always been at a loss to understand why all those cumbrous, trouble-giving, and expensive contrivances have been considered necessary, when, by a proper form of nipple, and a proper disposition of it on the breech, nothing else is required but a sufficiently strong priming in the percussion cap. Of the third description of breech-loading weapons the author says nothing; whilst, under the fourth head, he treats of the revolver principle as applied to pistols, and gives a decided preference to Adam's over Colt's; and with a reference to the kinds of gunpowder best suited to rifle practice, he ends this chapter of his work.

In writing upon the subject of substitutes for gunpowder for the charge of arms, he refers to gun cotton, and the great danger to be apprehended from the use of its explosive power in small arms.

The next subject treated of is the formation of rifled cannons; he then passes on to monster guns, and describes very accurately the construction of Mallet's monster mortar; then he also gives the particulars of the monster wrought-iron gun constructed at the Mersey forge; to these are added the particulars of the monster mortar at Antwerp, the chamber of which was constructed to hold 30 lbs. weight of powder, but this was ultimately burst with the charge of only 19·845 lbs. of powder.

To the bayonet the author devotes a short chapter; then follows an excellent chapter on novel appliances of war, which contains suggestions well worthy of serious consideration.

With a chapter on the relative power of ships and fortresses; another on methods of sub-marine attack; some suggestions on the best armament for a volunteer, and a few concluding remarks, the author finishes a work which does him credit; and as a contribution to this branch of scientific literature, will doubtless be found of considerable practical value, embracing, as it does, every branch of the subjects of which he professes to treat.

Abridgments of the Specifications Relating to Marine Propulsion (excluding Sails). Part 2. Published under the direction of the Commissioners of Patents.

On reference to page 209 of The Artizan for 1857 (Vol. XV.), our readers will find a notice of part of this useful series of abridgments, and we can only add to the remarks then made by us, that the present part reflects credit on the compiler, Mr. John Macgregor, the eminent Patent Law Barrister. The present part gives the abridgments of the specifications relating to this subject from 1831 to the end of 1847; and it is proposed that Part 3 shall contain the

abridgments to the end of December, 1857, together with an index of names, and a subject matter index, referring to all three parts of the work.

A Descriptive Catalogue of the Rock Specimens in the Museum of Practical Geology, with Explanatory Notices of their Nature and Mode of Occurrence, and of the Places where they are Found. By Andrew C. Ramsay, F.R.S.; Henry W. Bristow, F.G.S.; and Hilary Bauerman. Pp. 293. Eyre and Spottiswoode, London.

This is an excellent handbook of the rock specimens to be found carefully selected and systematically arranged in the Jermyn Street Museum, and it will be found admirably to illustrate the branch of science to which it relates.

The engineer and student in geology will find this catalogue a most valuable companion, not alone whilst inspecting the very beautiful and highly interesting collection referred to of specimens of the rocks of the British Isles, but the engineer will also find, when engaged in his study in projecting engineering works in any part of the British Isles, or whilst employed in any locality in the construction of works connected with railways, canals, harbours, mining, or even for bridge building, and, indeed, upon any kind of constructive works, a valuable *aide;* and we have often heard it remarked, that it was much to be deplored that engineers, as a body, knew but little about local geology. Messrs. Ramsay, Bristow, and Bauerman, have acquitted themselves admirably in the performance of a task by no means either light or simple, to be of real practical utility.

On Iron Ship Building, with Practical Illustrations. By John Grantham, C.E. London: John Weale.

Second Notice.

Mr. Grantham, in treating the subject of Iron Ship Building, does not attempt to discuss naval architecture, and the numerous debatable matters belonging thereto, and which might involve scientific investigations of a length and character which could only be fairly dealt with in a volume many times larger than the present work. We need only refer to the discussions which, for several years past, have occupied a considerable portion of space in The Artizan, involving a considerable amount of controversy, to understand why the author has confined himself strictly to the subject on which he undertook to write. He says, at pp. 2, 3:—

It was not the intention in this paper to advance anything on the subject of naval architectures, *per se*, or to discuss the comparative merits of the forms of ships, further than as it is thought that iron is more or less suitable to carry out certain known principles, or as it may be the means of raising the character of our merchant shipping, long enthralled by an absurd system of registry laws.

In a work like this, intended for the perusal of all classes interested in the advancement of this peculiarly national subject, it would be unwise to encumber it with mathematical investigations or dry arguments, in attempts to prove the various positions herein assumed. I aim at nothing more than its practical and popular features, and will appeal only to experience and common sense. The leading object is to communicate to others that knowledge which has been gained by upwards of thirty years of observation, and to promote a branch of practical science destined to occupy a very important place in the future trade of this country; and to give Great Britain a pre-eminence in the construction of our merchant shipping, which a few years ago, it seemed not improbable, would be transferred to other countries.

The author then proceeds to refer to the various changes which have taken place in connection with the science of navigation and the sciences in co-relation with it; and after claiming for Great Britain that pre-eminence to which we are so justly entitled in connection with this branch of science and industry, he says:—

The steam-engine of later years has made a new era in this important subject, and now, still later, the employment of iron as a material for shipbuilding is slowly but surely adding another link in the chain of modern improvements.

This innovation, as many have esteemed it, includes some of the points just referred to. Timber, for shipbuilding, has become scarce, and if required in large quantities must be nearly all imported. Our population has increased, and so have our wants, giving to trade a stimulus unknown to the world before; requiring a great increase in the size and number of our vessels; and the extraordinary development in our moral and social condition urges us to communicate to mankind through the means of improved navigation, and increasing trade, the stores of knowledge which we have acquired.

The author then gives the early history of iron vessels, which, as is known to most of our readers, is full of interest; and after bringing this history down to 1834, in speaking of the *Garry Owen*, built by Mr. John Laird, who at this time (says the author) was regularly engaged in building iron vessels, and who has, as Mr. Grantham informs us in a foot note, up to this time, 1858, built the large number of 225 vessels, having an aggregate of 88,000 tons, and 16,200 horse-power, he says:—

The *Garry Owen* was the first iron steamer which had a regular arrangement of water-tight bulkheads, the invention of Mr. C. W. Williams. Such appliances are now deemed essential to all iron vessels, and their adoption is enforced by Act of Parliament. At this time, also, Mr. Laird built two iron steamers for the River Euphrates, for the expedition headed by Major (now General) Chesney, one of which vessels, the *Euphrates*, is still at work on the Indus.

The author then states:—

In 1839, the *Nemesis* and *Phlegethon* were also built by Mr. Laird for the Honourable East India Company; the former of 660 tons, and the latter of 570 tons. These vessels are entitled to particular notice as being the first iron steamers that were engaged in fighting the battles of their country, and took a conspicuous part in the Chinese war of 1842. They gave early proof, of what has been since often confirmed, of the power of iron vessels to bear the concussion of heavy guns fired from their decks.

In referring to the progress which is made in iron ship building since this period, the author carefully traces the history, and remarks:—

The science which had been thus established, was pursued most actively in the Clyde, the Thames, the Mersey, and latterly in the Tyne; and no port of any magnitude but can claim now a share in the work. Builders can number the vessels built by them by tens and hundreds, and to attempt a list of the aggregate number built up to this time, in the United Kingdom, would be a work of no little difficulty.

In referring to the progress made in iron ship building abroad, he writes:—

The encouragement given to iron ship building in France by the admission of iron for that purpose duty free, has been the means of producing a large number of very fine vessels. In the extensive yards at Toulon, under the management of the Messrs. Taylor, I have seen as large and well-built vessels as any builder in England can produce.

For some years past iron vessels have been built in ports in the Baltic; and throughout the continent of Europe they are probably everywhere to be found.

With reference to the facility with which iron vessels can be repaired, and also in illustration of the variety of purpose for which iron ships are being adopted, he writes:—

During the late war with Russia, some of our iron vessels that had been seriously injured by collisions, were as neatly repaired at Constantinople as they would have been in our own yards; and the newspapers now tell us of an iron screw steamer that is leaving this country for the whale fisheries.

In illustration of the inch-by-inch battle against prejudice, which had to be fought in obtaining the substitution of iron instead of timber for building sailing ships for long voyages, the following quotation will serve to shew:—

But strange as it may appear, our shipowners long resisted the conviction that iron could be advantageously applied for building *sailing* ships required for long voyages. Some, however, are now yielding to the opinions we have so long urged, and many large and splendid specimens of naval architecture, in the form of iron sailing ships, are owned in every large port, but especially at Liverpool.

In concluding the historical sketch of the progress of iron ship building, Mr. Grantham, as might be expected, refers to the *Great Eastern*, or *Leviathan*, in the following paragraph:—

But the climax in the history of iron ship building is reached in the *Leviathan*, now building in the yard of Messrs. J. S. Russell and Co., Millwall. We cannot expect for many years, if ever again, to have occasion to notice a more stupendous illustration of all that can be said or argued in favour of iron as a material for ship building, than the *Leviathan* is likely to afford. We may already point to her as a proof of the facility of producing the largest structures with that simplicity and unity of design, and with that precision, that should ensure for iron ship building a confidence which need not be disturbed, and a character that cannot be questioned. Of her strength we have as yet no proof, though of this there can be little doubt.

Except, perhaps, as a matter of historical interest, it would not here be necessary to refer to this vessel in any other of its features; my object, in this work, being simply to point out the peculiar suitability of iron for the construction of ships of any size; but I feel unwilling in this case to omit an enumeration of some of the wonders which are necessarily involved in it. Neither does it come within the scope of this work to give any opinion as to the probable speed she is likely to attain, nor, as to the commercial prospects of this peculiar vessel. It may be asserted in general terms, that the speed of vessels increases with the increase of their dimensions; and that commercially iron ships, and particularly iron steam vessels, are much superior to timber-built ships, for reasons which will be more fully dwelt upon as we proceed.

After stating that he proposes, in another part of the work, to shew the connection between the subject of iron ships and the progress of steam navigation, he concludes this part of the work by stating—

The employment of iron, as a material for ship building, having excited much attention, and its evident advantages in several particulars for this object, led men who could not shake off their feelings of preference for the old system to substitute it partially, and apply it only to such parts as they supposed it to be best adapted for. Some attempted to use plates for the outside shell, to be stiffened by timber frames; others more successfully made the frame-work of iron, and still retained timber for the planking. A patent* was taken out about fifteen years since, to construct canal boats with the ribs made of angle iron, and the planks of timber, and some small vessels were built on this plan. Another patent was taken out a few years ago for the same object, and two ships of considerable size were built by the patentee.† These vessels exhibited the principle to great advantage, and have proved very successful. It would, perhaps, not be difficult to show that the iron frames of these vessels were expensive, and that the number of binding plates and other fastenings necessary to strengthen them would go far towards building a ship entirely of iron. But upon this point it would be better to leave experience and time to do their work in testing the merits of the system, as it is possible that for some purposes it may have advantages.

In the introduction to the division of the work relating to the construction of iron vessels, the author states—

With a view to the better elucidation of the subject I now proceed with a description of the ordinary method of constructing iron vessels. In doing this, it may be considered, by those engaged in the same pursuit, that I am laying open to the public eye the secrets of the business, and encouraging others to enter into competition with them. But although the principle of iron vessels can no longer be considered new, there is still much room for the exercise of ingenuity and practical skill; and it is desirable that the public should be made acquainted with the general principles on which we proceed, as the best means of giving confidence to the shipowner, and extending the demand for vessels of that material. It would conduce to our mutual interest to communicate to each other more freely the results of our experience, in order to insure as much as possible the introduction of every improvement, and thereby promote the employment of iron-built ships.

We fully concur with Mr. Grantham in his remarks on the importance for more free and frequent intercommunication and interchange of opinions, and the results of experiments by those practically engaged in shipbuilding; and what the author points out as desirable in these branches of science and industry, is equally required in many other branches of the applied sciences; and it is much to be regretted that so much low-minded vulgar prejudice and desire for exclusiveness, should exist in other trades and manufactures besides those connected with the building of iron ships: for it should not be forgotten that the little-minded exclusive member of society, who happens by some fortunate circumstance to be engaged in a scientific and progressive branch of art or manufacture, is like a drone in the hive of industry, and a clog to the machinery of

* By William Watson, Esq., of Dublin.

† Mr. W. Jordan, of Liverpool.

progress; whilst by all enlightened, liberal, and right-minded men, he should be held in contempt, and no opportunity should be lost in bringing him to a sense of his degradation;—for in the middle of the nineteenth century, in this age of progress, no man has a right to retard the advancement of science and material progress, by interrupting the free dissemination of knowledge, and should be shamed out of taking advantage of the intelligence and works of others for his pecuniary benefit or commercial advantage, whilst he at the same time refuses to contribute his mite to the common stock of knowledge, or prevents others from acquiring a knowledge of what he may have done that may be serviceable in guiding the unskilled, or in warning them off the shoals and rocks a-head, which more or less exist in the practice of every science, art, and manufacture.

The author, in explanation of the mode in which he proposes to treat the subject of construction, states—

It is the intention to describe only the *ordinary* mode of construction, as now generally adopted, and not attempt to suggest new and untried plans, although it is easy to conceive that the subject admits of much improvement.

He then proceeds to describe the keels of iron ships, their construction and use; advancing to the stem and stern-posts, he proceeds to describe the frames and floorings, and also the keelsons, sister keelsons, and bilge pieces; next the beams are described, as also the gunwales and stringers. Having advanced thus far with the construction of a ship, the lower decks, hold beams, and stringers are treated of, and the advantages of diagonal ties, applied in various positions, are discussed; the mode of introducing iron stanchions, for supporting the deck beams and preserving the correct form of the ship, is detailed.

The internal structure of the ship having thus far advanced, and it being supposed to be in frame, the plating is next considered by the author, and that necessitates the consideration of the mode of rivetting, and the discussion of the form, proportion, and disposition of the rivets employed. The application of bulkheads is discussed, and the author expresses an opinion that, in addition to the ordinary transverse bulkheads, all large vessels should also have longitudinal divisions by water-tight bulkheads.

After treating briefly of iron masts, and comparing the weight of wood masts with hoops and iron work with those constructed entirely of iron, by which he shews, in a particular case, that in the weight of the three lower masts and bowsprit of a ship, there was a saving in weight of 9 tons, or that the wooden masts and bowsprit weighed nearly 50 per cent. more than the iron masts, the latter weighing only 18 tons 10 cwt., whilst the wood masts weighed 27 tons 10 cwt., he proceeds to describe minutely the process of building an iron ship, and then treats practically of the several main parts of a ship (referred to in the plates which accompany the text), and, after describing the manufactured iron used for frames, beams, &c., he strongly impresses upon builders the serious importance of employing iron of the best quality for the plates, frame irons, and rivets; and we cannot too emphatically second Mr. Grantham in calling upon iron ship builders to act upon the true conservative principles which should govern trade, and honestly to resist the temptation to use inferior iron, and thereby for the future avoid the reproach which has been cast upon them repeatedly of late, of dishonestly substituting cheap iron, of uncertain character, for what is commonly understood to be *the best iron*, as so specified. To this subject reference has more than once before been made in THE ARTIZAN; and as we know, from cases which have come under our personal knowledge, with very good cause; and we hope that this matter will not be permitted to rest where it does, but that it will be followed up by those who are competent to discuss the question, that no such disgraceful exhibitions may again occur as those which we have heard have occurred in London with an eminent ship-building firm, by which it would appear that one or more of the most eminent engineers has decided "that the common Staffordshire iron, supplied for the frame-work and plating of a ship of large dimensions, and where it would be probably subjected to heavy and unequal strains, was equal to the *best London made 'scrap iron,'* and that it might fairly be substituted for it."

Mr. Grantham, whilst treating of the quality of iron, remarks as follows:—

We should not, however, rest satisfied that we have attained in the present mode of manufacturing iron the highest degree of excellence. Iron is susceptible of changes in its chemical condition that produces effects of the most astonishing character; for instance, when iron is converted into cast or blistered steel, which is done by a simple process of the combination of the carbon of common charcoal under heat, its power to resist tension is increased from 25 tons to 60 tons, as the breaking point of a bar having an area of one square inch.

Of Shortridge, Howell, and Jessop's homogeneous metal, and the advantage which may be expected from its employment for plating iron ships, he says, in continuation—

A process has been discovered by which they produce nearly the same results by means closely allied to the manufacture of steel. It is called Howell's Homogeneous Metal, and an inch bar on being tested at the Liverpool cable-testing machine, broke with a strain of 53 tons, rather more than double the best English bar iron, and nearly equal to that of cast steel. The iron thus converted is ductile, malleable, and welds with facility; besides having other properties adapting it to iron ship building. I am informed by the makers that its price, for large quantities, may in time be reduced to £30 per ton; while iron plates are, at their present price, of about £10 per ton, and as less than half the weight is necessary, the cost is not widely different, while the advantages resulting from the difference of weight are very important. The power of this metal to resist oxidation and the action of fire, are also said to be very superior to common iron. From all these causes, a confident expectation is held out that its employment in shipbuilding may not be far distant.

I do not here give any opinion as to the result, but draw attention to it as a subject of great interest, in the promotion of iron ship building, and trust that improvements in this direction may not be overlooked.

It is worthy of remark here, that Mr. John Laird, the great pioneer of iron ship building, has taken the initiative in the application of this homogenous metal for shipbuilding purposes; and with that commendable spirit of scientific and commercial enterprise which has marked his career, has employed it in building the vessel intended to carry Dr. Livingstone in his mission of civilization, commerce, and industry, into the very heart of the almost unknown regions of Africa; and those who desire to know something more of the practical merits of this material, may refer to a report of some experiments by Mr. William Clay, of the Mersey Forge, which were detailed by him in a paper read at a recent meeting of the Society of Arts, and reported in THE ARTIZAN the 1st February.

The author next proceeds to describe the machines and tools used in iron ship building, in which, although there is nothing very new, possesses the merit of clearness and useful advice.

The advantage of employment of water for ballasting ships is pointed out, and the modes of best making this means available are described.

To the consideration of the commercial advantages of iron ships, as compared with wood ships, the author devotes some twenty-four pages; and to what he is pleased to call the national question involved in the preference given to iron over wood as a material for ship building, devotes a fair share of space, and, to our opinion, clearly demonstrates the soundness of the views he advanced long ago.

Upon the subject of the application of the compass, its derangement, and the means employed for ensuring its correctness, Mr. Grantham gives the latest views, and describes the most recent improvements adopted; so, in like manner, he treats of the various other details of a ship and her fittings.

A notice of the *Leviathan* is next given, and a pretty accurate description, with numerous illustrations, concludes this portion of Mr. Grantham's book; this is followed by Lloyd's rules for the building of sea-going iron ships, and various other matters in connection with iron ships. He then gives numerous specifications of paddle and screw steamers and sailing ships; and we select the following as a useful example, being a specification of an iron screw collier, &c.

Iron Screw Collier, "William Cory," built by Messrs. C. Mitchell and Co., Low Walker, Newcastle-on-Tyne, 1857.

Dimensions.—Length all over, 252 ft.; length on 11 ft. water line, 240 ft.; beam, moulded, 35 ft; depth, 18 ft. 9 in.; tonnage, B.M., 1,500.

Keel and Stem, of hammered iron, 11 × 2½ in., in long lengths, with strong scarphs.

Stern Post and Screw, frame of hammered iron, 11 × 5 in., with boss for screw shaft, as required.

Rudder Stock to be 5 in., with 5-16ths in. plates on blade.

Frames, of angle-iron, 5 × 3½ × 9-16ths in., spaced 18 in. from centre to centre throughout. In holds, each frame in three lengths, one to extend across the bottom from bilge to bilge, terminating at iron ceiling, and the others to extend down each side of ship, from gunwale to iron ceiling, where a knee is to be formed, and the frame returned on tops of ceiling as far as is requisite to maintain equal strength; these knees are to be strengthened by a knee plate, not less than 30 in. sided, and 9-16ths in. thick. Fore-and-aft of holds the frames to be in two lengths, as usual; each frame to be well rivetted to plating and iron ceiling.

Floorings on every frame throughout, those in holds to be formed of plates 20 × ½ in.; fore-and-aft to be of increased depth to suit the form of ship.

Reverse Angle-Irons throughout to be angle-iron 3½ × 3 × ½ in. well rivetted to frames and floorings. In holds, to be on every frame, extending down alternately from gunwale and from 18 in. above hold beams to iron ceiling, also on top edge of each floor, from bilge to bilge fore-and-aft, as required.

Keelsons in holds to be seven in number, formed of plates 24 × 9-16ths in. in as long lengths as possible, with two angle-irons, 3 × 3½ × ½ in. rivetted on each edge, to be strongly rivetted to reverse angle-irons. Bulkheads and iron ceiling beams. Keelsons fore-and-aft as required.

Bilge Keels to be placed each side of keel, and formed of bulb beam-iron 8 × 9-16ths in. with two angle-irons 6 × 4 × ½ in. well rivetted to bottom plating; each bilge keel to extend not less than 100 ft. amidships.

Water Ballast Chambers to be perfectly water-tight, and formed by the bottom plating, and a plate-iron ceiling extending from bilge to bilge in the holds, and placed 4 ft. above the tops of keel; this ceiling to be of plate-iron, not less than 7-16ths in. thick, attached to athwart ship beams resting on keelsons; these beams to be formed of two angle-irons, 4 × 3 × 7-16ths in., and 3 × 3 × ⅝ in. rivetted together, and to iron ceiling, keelsons, and frames; one of these beams to be over each flooring. A knee plate, ½ in. thick, and extending at least 3 ft. along ceiling beams, to be placed on each frame at bilge under ceiling plate, and well rivetted to frames and ceiling beams. The water-tight joints, when the iron ceiling meets the outside plating and bulkheads, to be formed as follows:—The edge plate of iron ceiling all round inside holds to be ½ in. thick, and of such a quality that a 6 in. flange can be turned upon its edge without any loss of strength or soundness; this flange to be on the upper side, and double rivetted to outside plating and bulkheads, and being carefully worked and caulked, will form the water-tight joint between iron ceiling and hold of ship. Air and other pipes, cock, &c., as required, for rapidly filling and discharging the water ballast, as may be found requisite.

Bulkheads to be five in number, of 7-16ths in. plate, stiffened with vertical bars of angle-iron, 3 × 3 × ⅝ in. spaced about 24 in. apart. To be caulked and made water-tight, excepting the forepeak bulkhead. All bulkheads are to be fitted with large brass cocks, placed as low as possible, with handles leading to the deck, to be used in case of leakage. Each bulkhead to have double angle-irons on top edges, same as deck beams.

Engine and Boiler Seating to be formed of stout plate and angle iron, as required, for the secure fixing of engines and boilers.

Coal Bunkers to be capable of containing 150 tons of coals; plating to be not less than 3-16ths in. thick, stiffened by angle iron 3 × 3 × ⅝ in., spaced about 30 in. apart; iron stays across bunkers, as requisite, to be fitted with four feeding and two trimming doors, and scuttles on deck, as required. Along side boilers the upper edge of bunkers to have angle iron to form the boiler hatch, with short beams to ship's sides.

Hold Beams of plate iron, 10 × ½ in., with two angle-irons, 5 × 3 × 7-16th in., rivetted on top edge, and two ditto on bottom edge, and to have a plate, 12 × ⅝ in., rivetted on top of each beam, to be spaced not more than 9 ft. from centre to centre; to be well secured to frames and hold stringers.

Hold Stringers to extend the length of vessel, to be formed of plates, 27 × ½ in., in long lengths, well rivetted to hold beams, and secured to reverse angle irons and bulkheads by angle iron, 6 × 4 × ½ in.

Clamp Plate.—To have a clamp plate, 18 × ½, extending all round the vessel, attached to frames immediately above hold stringer, and firmly rivetted to reverse angle-irons, and to gunwale stringer angle-iron.

Hold Stanchions, of 3 in. round iron, strongly secured to deck and hold beams, and iron ceiling, to be placed under and over every hold beam: at hatchways to be on each side.

Deck Beams to be one on every alternate frame, formed of patent beam iron, 8 × ⅝ in., with two angle-irons, 3 × 3 × ⅝ in., rivetted to the upper edge. Hatchway beams and framing of additional strength, as required.

Knee Plates of plate iron, not less than $\frac{1}{2}$ in. thick, and not less than 18 in. sided, to be rivetted to each deck and hold beam, and frame at side of ship.

Gunwale Stringer of plate iron, 27 × $\frac{1}{2}$ in. for 150 ft. amidship, tapering to 20 × $\frac{1}{2}$ in. fore and aft, to be in long lengths, and attached to sheer strake by an angle-iron, 6 × 4 × $\frac{1}{2}$ in. on upper side, double rivetted on each flange.

Deck Ties of plate iron, 14 × $\frac{3}{8}$ in., in long lengths, on each side of hatchways, and extending the entire length of vessel, also placed diagonally, and well rivetted to deck-beams and gunwale stringer.

Forecastle Sole Beams of angle iron, 5 × 3 × $\frac{1}{2}$ in., spaced one on each alternate frame, with fore-and-aft stringer on the under side, of angle iron, 6 × 4 × $\frac{1}{2}$ in., rivetted to each frame-beam.

Top Gallant Forecastle Beams of angle iron, 5 × 3 × $\frac{1}{2}$ in., spaced as deck-beams.

Sundry Fittings.—Mast and bitt partners, and other strengthening plates and angle iron as required.

Plating.—Keel strake 13-16ths of an inch; bottom, bilge, and sheer strake, 11-16ths of an inch; bilge plate in line of iron ceiling, 3-4ths of an inch; sides, 9-16ths of an inch. The gunwale to be further strengthened by a plate, 15 × $\frac{1}{2}$ in., worked on and secured to the outside of sheer strake in as long lengths as possible, to break joint with sheer strake. The sheer strake to be carried 10 in. above gunwale stringer all round the ship. All the plating and angle iron to be worked in as long lengths as possible, with strong joints to maintain equal strength throughout. All laminated or defective material to be rejected, and both workmanship and material throughout to be sound, and of the best quality.

Rivetting.—The keel and stern to be double rivetted, and the stern-post and propeller frame to be treble rivetted, with 1$\frac{1}{8}$ in. rivets. All butt joints in stringer plates and deck ties to be treble rivetted; all butt joints in outside plating, plate-iron ceiling, floor-plates, and keelsons, to be double rivetted. The rivets to be countersunk on outside plating, plate-iron ceiling, and gunwale stringer: bottom, bilge, keel, stem, and stern-post rivets to be left full, and not made quite flush.

Painting, &c.—All the iron work to receive at least three coats of good oil paint; the bulwarks, deck fittings, and houses to be well painted. All iron work to be well painted with red lead before receiving the wood work.

We now give an extract from the "conclusion" of Mr. Grantham's very useful book. He says:—

It has been my aim in the foregoing remarks to bring the reader, by plain and easy steps, to a review of the whole question—the origin, progress, and present position of iron ships and shipbuilding, from the time when it was difficult to convince many that iron would "float," to the present time, when an advertisement, headed, "A First Class *Iron* Steamer" conveys a recommendation to the public superior to all other claims for preference; and when even an underwriter no longer hesitates to consider an iron ship bound for India a first-class risk.

Should it be mine and the reader's fate to meet again after another lapse of fifteen years, I cannot doubt what I should have to record—improvements as great, perhaps, as the last fifteen years have seen, for there is still ample room for them. Not one, perhaps, of the present race of wooden steamers left; and few, if any, wooden ships of any description building. In the meantime, let shipbuilders be faithful to themselves, and not be tempted to do inferior work; let underwriters and shipowners work together, laying aside prejudice, and not thwarting the energies of the men who have brought this science to its present stage.

To the last paragraph of the above extract we say sincerely, Amen! and heartily wishing that Mr. Grantham's object, in devoting the time which he has expended upon so useful a work, may be fully realized, and that this truly national and important branch of industry may go on increasing with the advancement of science, and with the development of the other material resources of the empire—in which development it has played no unimportant part. We take leave for the present of the author and his excellent treatise on iron ship building, commending it, as we conscientiously can do, to the perusal of ALL who are or may be interested in the subject.

LIST OF NEW BOOKS OR NEW EDITIONS OF BOOKS.

ROSE (J.)—A New Guide to the Iron Trade; or, Mill Managers' and Stock Takers' Assistant: comprising a Series of New and Comprehensive Tables, practically arranged, to show at one View the Weight of Iron required to produce Boiler Plates, Sheet Iron, and Flat, Square, and Round Bars; as well as Hoop or Strip Iron of any Dimensions; with Tables for Convenience of Merchants. By James Rose. 8vo, pp. 100, bound, 8s. 6d. (Mining Journal Office.)

TIMBS (J.)—The Year-Book of Facts in Science and Art; exhibiting the most Important Discoveries and Improvements of the Past Year in Mechanics and the Useful Arts, Natural Philosophy, Electricity, Chemistry, Zoology and Botany, Geology and Mineralogy, Meteorology and Astronomy. By John Timbs. 12mo, pp. 290, cloth, 5s. (Kent.)

BOWMAN (J. E.)—An Introduction to Practical Chemistry, including Analysis. By John E. Bowman; edited by C. L. Bloxam. 3rd edition, 12mo, pp. 290, cloth, 6s. 6d. (Churchill.)

GRANTHAM (J.)—Iron Ship Building; with Practical Illustrations. By John Grantham. 12mo, pp. 230, cloth, 2s. 6d. (Weale.)

HADFIELD (H. H.)—A Treatise on Perspective, explanatory of a System for Simplifying a Knowledge thereof. Illustrated by a large sheet of coloured diagrams. By H. H. Hadfield. 12mo, cloth, 5s. (Winsor and N.)

MURRAY (R.)—Rudimentary Treatise on Marine Engines and Steam Vessels; together with Practical Remarks on the Screw and Propelling Power, as used in the Royal and Merchant Navy. By Robert Murray. 3rd edition, 12mo, pp. 190, cloth, 2s. 6d. (Weale.)

SCOFFERN (J.)—Projectile Weapons of War and Explosive Compounds. By J. Scoffern. 3rd edition, post 8vo, pp. 310, cloth, 8s. 6d. (Longman.)

LAW CASES.

VANCE *v.* BOND.

This was a bill for the administration of the estate of the late Captain Carpenter, the inventor of the screw propeller, for the purpose of obtaining certain inquiries as to the proceedings to be taken against those who infringed the patent, and for the recovery of the sum of £20,000, which had been granted by the Legislature as a reward for the invention, and which sum was now in the hands of trustees. Mr. Beavan and Mr. Hetherington appeared for the different parties.—The Vice-Chancellor made a decree according to the prayer of the bill.

PHILLIPS *v.* MELEN.

This was an action brought to try the validity of the plaintiff's patent. The defendant pleaded the usual pleas placed upon the record in such causes, the principal one being a denial of the novelty of plaintiff's invention. Mr. Grove and Mr. Kingdon appeared for the plaintiff, and Mr. Sergeant Parry and Mr. Henry James represented the defendant. It appeared that the plaintiff was the principal chemical officer of the Excise, and that he also carried on the business of a tobacconist and pipe manufactory, at 89, Holborn. He claimed to be the inventor of a pipe called the *Patent Charcoal Filter Pipe*, the object of which was, by means of a charcoal filter, inserted in a glass tube about 1 ft. long and 1 in. in diameter, which formed the stem of the pipe, to separate the deleterious matters, nicotine and nicotianine, from the tobacco smoke, and so to destroy its narcotic and injurious properties. The defendant, who was a tobacconist carrying on business at Shoreditch, had made and sold a pipe similar in principle to, although smaller than the plaintiff's.

A great deal of contradictory evidence having been given, the jury ultimately returned a verdict for the plaintiff, being of opinion that the invention was a new and effectual invention. The parties then agreed to take a verdict for the plaintiff for 40s.

THE STEAM-ENGINE.—IMPORTANT PATENT CASE.

At the Rochdale County Court a special sitting was held before Mr. J. S. Greene, judge, to try a case in which Mr. Samuel Fielding claimed £50 as his share in a patent, entered in April, 1855, for lubricating the piston and inner surface of the cylinder of the steam-engine; and which patent he alleged the defendant, Mr. William M'Naught, machinist, had infringed by a patent entered in April, 1856. For the plaintiff, Mr. Roberts, of the late firm of Sharp and Roberts, of Manchester, gave evidence to the effect that he believed Mr. M'Naught's apparatus was an infringement of Fielding's. The specification of Mr. Fielding sets up a claim for the use and employment of mechanism for the purpose of oiling and lubricating the pistons of steam-engines, by the aid of certain descriptions of machinery, set forth in the specifications, which included a ratchet-wheel, a lever, a plunger, and some piping, by means of which the oil was introduced into the cylinder, in the case of low-pressure engines, by its own gravity, the plunger being used in high-pressure engines to force in the oil against the steam. M'Naught claimed, in his specification, for an invention for conveying oil or other lubricating material to the cylinders and pistons of steam-engines, by causing it to enter, or to be drawn through, apertures previously formed round the periphery of the cylinder, and set with the ring of the piston's stroke. In defence, it was urged by Mr. Marsh, first, that the ratchet-wheel, the lever, the plunger, and the piping, were old inventions; and, second, that the means of causing the oil to enter were by different agencies; that while, in Fielding's patent, the plunger was used to force in the oil, in M'Naught's the arrangement was such as to shut off all external pressure, and at that particular period, the pressure of the steam being equal on all sides, oil being a heavier body, fell into its proper place by its own gravity. Messrs. David Cheetum, and Benjamin Fothergill (of Manchester), were called to prove this position. The judge said he would look over the cases cited, and give judgment in three weeks. The public hall, where the case was heard, was crowded during the trial, which lasted five hours.

At the Rochdale County Court, Feb. 18, Mr. J. S. Turner Green gave judgment in the case Fielding *v.* M'Naught. His Honour said, that the great object of Fielding's patent was to make the piston self-supplying with lubricating matter. The ratchet wheel, the motion from the engine, the lever, were not rendered new by combination. In both cases there was what had been called a plunger; but it was a question whether these two implements acted in the same way, were from the same idea, and were the same invention, for conveying the lubricating matter to the portions requiring it. He was of opinion that they were substantially different. Although each was called a plunger, they were different and distinct—different in their mode of operation, and distinct in the idea of each invention; for one acted by outward force, the other took advantage of a law of nature—gravitation. The verdict would therefore be for the defendant.

NOTES AND NOVELTIES.

MISCELLANEOUS.

The Ordnance Survey.—A Royal Commission has been appointed to inquire into the scale or scales upon which the lines and plans of the United Kingdom can be drawn and printed. The Earl of Rosse, Dr. Griffith, of the Irish Board of Works, and nine others, are members of the Commission.

Beccles.—The steam mill, erected by Messrs. Easton and Amos, for the drainage of the Corporation marshes is completed. The apparatus for raising the water consists of an Appold pump. The fan, 2 ft. 9 in. in diameter, works horizontally, in a strong cast-iron cistern; a pair of high-pressure expansive and condensing vertical grasshopper engines, of 10 horse power each, are placed and attached to each side of the iron-cistern, the fly-wheel, shaft, &c., being at the top and over it. The whole machinery is placed in such a compact manner as to occupy but a very small space. The boiler is multi-tubular, with a large steam-chest; and a stout iron-funnel, 23 ft. high, acts as a chimney shaft. The whole building is of red brick, with corrugated iron roof, no wood being used except for the doors. A convenient coal-house is formed in that portion of the structure next the boiler.

The Shells thrown at Napoleon were made by Mr. Taylor, an engineer, in Broad-street, who was, of course, unacquainted with the purposes for which they were intended. They are most ingeniously contrived, and the one brought to our office was a very fine specimen of workmanship. It is cylindrical in shape, with the ends rounded, resembling a melon more than anything else we can compare it to,—the size about 5 in. by 4 in. It is hollow, and made in two parts. The thickness of the metal at one end is 1 in., at the other, $\frac{3}{4}$ of an inch. The great peculiarity in the construction is the means for exploding. In an ordinary hand grenade this is provided for by a fusee, which, being lit, when it reaches the powder causes the explosion. In the present instance, one end of the shell is provided with 25 nipples, similar to those of a gun, and upon each of these a percussion cap is placed. When either of these caps strikes against any substance it produces the explosion; thus all uncertainty as to the time of the explosion is avoided. The extra thickness of the metal at this end secures its falling the right way. At the opposite end is a hole for loading, which is closed by a screw-plug. The whole appearance of the machine is of a most dangerous kind, and on its construction and design great labour must have been bestowed. —*Birmingham Journal.*

The Boydell's Traction Engine, lately purchased by the War Department, for service in the Arsenal, was tried February 4th at Woolwich, before officers appointed by the East India Board of Directors. The engine left the Arsenal gates at 2·30, travelling first at the rate of 6 miles per hour, with a train of four heavy artillery carriages, each bearing a heavy 9-in. siege gun, the entire load being about 43 tons.

Captain O'Connor and Mr. Duesbury, of the Central American Railway, inspected the Patent Endless Railway, at the Royal Arsenal, Woolwich, with a view of purchasing several of them, to be used in the construction of the Central American line, from Sacramento to San José. Lieut. Oussoff, a Russian officer of engineers, is superintending the construction of several engines to be used for the conveyance of merchandise between Heva (on the Black Sea) and Buckara.

Mr. William Williams, the contractor for the battery built by the War Department at Dale, has been awarded a Silver Medal by the Royal Society of Arts, for a stone-cutting machine, which he has patented.

That knowledge is power is stongly evidenced by the immunity from disaster enjoyed by a village on the north coast, where, prior to the recent tempests, warned by the indications of the barometer, the fishermen deferred their departure, and have saved the sad fate that awaited the blind temerity of their ignorant neighbours.

Monsieur Thome de Gamond's Tunnel between England and France.—The French Commission, after examining the scheme in all its details, has come to the conclusion that it is feasible, and ought to be seriously entertained, and it has recommended the Government to disburse £20,000 for the purpose of making new investigations respecting it. The same Commission recommend that the English Government should be requested to say if it be disposed to take any part in these investigations.

Public Works in India.—A return to a motion of Colonel Sykes, M.P., in the House of Commons, gives the budgets of the Public Works in India for the years 1853-54 to 1856-57, or likely to be expended in that year, was 2,20,15,420 rupees, against 2,47,48,219 rupees in 1855-56.

It is said that Ferukh Khan, the Persian ambassador, before leaving France for Italy, acting on a special authority from his Government, signed a treaty with a Paris merchant for the exclusive spinning, by machinery, during twenty-five years, of all the silk produced in Persia.

A Chimney, 90 feet high, at Mr. Thornham's Saw Mills, Hull, which had deflected 2 ft. 9 in. from its perpendicular, has been successfully straightened. The old foundations having decayed, 3 or 4 feet of fresh concrete was laid down. A basement of brickwork was built around to, within 2 feet of an iron collar 7 feet from the ground. Two 6-inch timbers were then placed—one on the basement, and the other under the collar. The chimney was then cut between these timbers, and restored to its perpendicular by wedges. The chimney had been built twenty years.

Mr. Robert Mallet has left for Naples, to make researches into the phenomena of the recent earthquakes, a sum of money having been placed at his disposal for that purpose.

The Decimal System, so far as weights, has just been adopted by Mecklenburgh, most of the German States, and Denmark.

M. Scheutz, an ingenious Swedish inventor, has received an order to make a calculating machine for the use of the Department of the Registrar-General.

Mr. Whitworth is engaged in making a Monster Printing Machine for the "Times." Between twenty and twenty-five thousand copies per hour will be turned off. A similar machine is being made for the "Manchester Examiner and Times."

Vancouver's Island.—Government has determined that a scientific exploration shall be made; and with this view the Royal and Geographical Societies have been requested to furnish suggestions.

The Tenth Annual Exhibition of Inventions, in connection with the Society of Arts, will be opened on the 5th of April.

The Netherlands Land Enclosure Company have received information that the recent storm on the coast of Holland has occasioned great injury to the Polder Bank of the Company's second enclosure. The Company is now engaged in devising the best course to be adopted.

Stoneham and Lees' Improved Unions for Lead and Composition Pipes.—The process appears to be a simple one, effected by a couple of small tools, together with the patent union, and a screw cut on the end of one of the pipes to be united. The other pipe end is heaten out into a sloping or conical mouth, which fits into one end of the union, while the other end of the same union receives the screw end of the pipe to be united with the conical-mouthed one. Between the two a washer of wood is placed, which is designed to make the joint complete when screwed up by the tongs or vice supplied for the purpose.

Nature Printing.—Mr. Henry Bradbury has received the Belgian Gold Medal of Merit.

At Elsecar, near Rotherham, an intelligent miner has fitted up a Turkish bath, a luxury which seems to have been well appreciated, many persons, chiefly colliers, using it.

Lord Clarendon has given a free passage to Naples to Mr. William Watt, brother of the engineer, Henry Watt, now under trial at Salerno. His lordship says he has had much satisfaction in giving this order.

Mr. Hawksley has been appointed consulting engineer for the Rivington Waterworks, at a salary of 200 guineas per annum, and travelling expenses.

Drying Oil.—Old linseed oil, if mixed with protoborate of manganese, in the proportion of an ounce to the gallon of oil, and kept in a close vessel for two days, exposed to a heat of 212 deg. Fah., in a steam-bath, and frequently stirred during that time, makes a beautiful drying oil for paints. Dr. J. Hoffman, the eminent German chemist, says, "it becomes by this treatment of a clear greenish yellow colour, remains thin even when cold, and zinc white paint mixed with it dries in twenty-four hours.—*Scientific American*.

An Iron Girder Railway Bridge has fallen in at Langley, near Watford, on the North-Western line.

RAILWAYS, &c.

London and Blackwall.—Two new sources of revenue will be opened in the course of a few weeks, viz.—The Bow and Barking branch of the Tilbury line, and the new Goods Station at the Minories.

The Railway Terminus in Westminster.—An arrangement has been made by the directors of the Brighton and South Coast Railway Company, with the new company formed, for the construction of a short line, with terminus at the Grosvenor Basin, Victoria Street, Westminster, and crossing the Thames to Battersea, and the Crystal Palace West-end Line.

Stockton and Darlington.—The estimate for the proposed new branches and a bridge at Stockton, amounts to nearly £150,000.

Colne Valley and Halstead.—The works on this line are immediately to be proceeded with by Mr. Munro, the contractor.

Sunderland and Hartlepool.—A new branch line, securing direct communication between these ports, has been opened.

Worcester and Hereford.—Mr. Brassey has contracted for the execution of the works on this line.

Newall and Fay's Railway Brake.—The experiments of Colonel Yolland are stated to have been successful. The brake locks up the wheels of every carriage.

Cornwall.—The works on the Albert Bridge are progressing. The permanent way on the entire line will be ready for traffic as soon as the bridge is completed.

East Kent Line.—The first section has been opened from Faversham to Chatham.

The branch railway from Rainford to Ormskirk, completing the communication between St. Helen's and Southport, will be opened on the 1st March.

Dartmouth and Torbay.—The first sod has been cut.

South Durham and Lancashire Union.—The Tees Bridge is far advanced in two of the piers; the whole of the foundation for the Deepdale Bridge piers are in a forward state. Preparation and trial pits are going on at Bealah Ravine. The contracts over Stainmoor are shortly to be let.

Mr. Bruff has been appointed by the Norfolk and Eastern Union Companies, inspecting engineer of their way and works. Mr. Bruff has commenced proceedings to recover from the Eastern Counties Company upwards of £6,000 for professional services.

Yeovil and Exeter Railway.—The works on this line have made great progress lately. The difficulty with respect to the Honiton Tunnel has been nearly surmounted. Three or four of the shafts are in a bed of green sand, which causes the water to rise rapidly. This difficulty will be got over when the "headings" are carried through the tunnel. All the works are now proceeding rapidly from Yeovil to Crewkerne. Of the tunnel at Maiden Beech Tree, a length of 220 yards, there only remains 15 yards to complete. Near Exeter several cuttings have been commenced.

Llanelly.—A bill is before Parliament to enable the directors of this line to lease the Towy Vale Railway.

Taff Vale.—Mr. Clements, locomotive superintendent, has resigned. He was formerly engineer of the *Great Britain*.

Streamstown to Clara.—The cost of this branch line will be about £15,000.

Belfast and County Down.—Sir John McNeill's estimate for the works, and necessary property for the same, is £250,000.

Dublin and Wicklow.—Workmen are busily employed at the Dublin Terminus, and the piers and arches across Harcourt Road are being constructed.

United States and Canada.—The Welland Railway, which was only 25 miles in length, extended from Port Colborne, on Lake Erie, to Port Dalhousie, on Lake Ontario, thus connecting many thousand miles of navigable waters at the cheapest possible rate of transit. The gradients of the railway descended in the direction of the trade. The traffic would consist of grain and other produce from the Western States, which already contained about 10,000,000 people. The traffic would be conveyed from Chicago, round by the Lakes Michigan and Erie, to their line at Port Colborne, and over the railway to New York, Portland, Quebec, or Boston, at less than by any other railway. The freight would be conveyed from their terminus at Port Dalhousie down Lake Ontario to the Grand Trunk of Canada Railway at Prescott, thence to Montreal, and, on the completion of the Victoria Bridge, to Quebec and Portland, thereby securing the cheapest route for the conveyance of freight between the Western States and the Atlantic.

The Cape.—A prospectus has been issued of a Cape Town Railway and Dock Company.—Mr. Brounger, the engineer, has made a flying survey of the country between Cape Town and Wellington, and has been engaged with his assistants in making sections preparatory to fixing the route, and tendering for the execution of the line.

Australia.—The extension of the works of the Northern railway of New South Wales has been resumed at East and West Maitland.

Victoria.—The railway question which has so long agitated public opinion in Victoria, is definitely settled, and the principle has at length been affirmed by both branches of the legislature, that two trunk lines are to be constructed, one from Melbourne to the Murray, the other from Geelong to Ballarat.

Adelaide.—Railway works are contemplated in this colony to the amount of £7,000,000.

Recife and San Francisco Railway.—The opening of the 18 miles of this line, appointed for the 2nd of December, has been postponed, to fence in the railway for the protection of stray cattle, and the avoidance of accidents.

France.—Brittany Railway.—The section from Alençon to Argentan, 30 miles, has been opened, establishing a communication between Vingt-Hanaps, Sees, Almeneches, and Argentan.

Locomotives.—It is said that M. Duterte, engineer, has invented an apparatus which will effect a complete revolution in the construction of locomotives, and save 50 per cent. in the consumption of fuel.

The Prospectus has been issued of the Medoc Railway from Bordeaux to Verdon, with a capital of £600,000. The length of the line is 60 miles, and it appears to possess several advantageous features. The board of direction is exclusively French.

On the French North Line a New Signal has been introduced, which, independent of the alarum signal, will permit the guard and other *employés* in the train to communicate with the engine-driver without leaving their assigned place.

Caen to Cherbourg.—It is expected that this line will be opened for passengers in July next.

Great Luxembourg.—The whole line will be finished to Arlon in the course of the ensuing summer.

The inauguration of the railway from Mons to Hautmont, in Belgium, took place a few days ago. The new line shortens the distance between Paris and Brussels by 45 kilometres (28 miles).

Algeria.—The line from Algeria to Blidah is first to be made. It will be constructed by the military. The line from Philippe-ville to Constantine will be constructed by a company. The preliminary surveys are now being made.

Geneva Railway.—The branch which is to connect it with the Victor Emmanuel line, is being actively proceeded with. The four tunnels have been commenced. St. Innocent, 160 metres long; Colombière, 1,300; Brison, 600; Grand Rocher, 240.

Spain.—The Madrid and Alicante Railway is opened: length, 300 miles. It is proposed to make a tramroad, to be worked by horses, in order to unite Calzas de Mombuy to the railway from Barcelona to Granollers.

Several thousand additional men are about to be employed on the works of the Northern Railway of Spain. The Government has decided that the terminus of the Northern Railway shall be established at Madrid, near the San Vincente Gate.

Italy.—The Pio Central Railway is already far advanced. The sections between Fano and Pesaro, and between the latter place and La Cattolica, are completed. The tunnel, which is to be pierced through the mountains at that place, is already commenced.

The Turin journals announce that the cutting through of Mount Cenis has commenced, and that about twenty yards have already been excavated. The system employed thus far has been the ordinary one of blasting, but the great machine specially constructed for boring through the mountain will soon be brought into use, and the cuttings for facilitating access at each end are completed.

Germany.—The works on the railway from the Marne to the Rhine (Mentz, Darmstadt and Aschaffenbourg) are progressing very rapidly.

The railroad on the left bank of the Rhine, from Rolandseck to Remagen, will be opened in a few weeks; it will have attained Buhl in the spring, and by autumn it will have been carried to Coblentz—when the railway communication between that town and Cologne will be continuous.

Russia.—Riga and Dunaburg line.—The statutes of this company have been settled, and await the signature of the Russian Government. The ironmasters of Belgium are to supply during the next four years 176,000 tons of rails for the Russian railways.

India.—A return from the East India Company, prepared at the request of Parliament, shows that the engineering plans have been adopted for 3,700 miles of permanent way. The gauge throughout is to be 5 ft. 6 in., and there will be a double line of rails, a single line being down until the traffic is developed. Average rate of construction, £9,000 per mile. The Government gives the land.

Ceylon.—Mr. W. T. Doyne, a gentlemen of high professional attainments, has been appointed principal engineer of the Company in Ceylon; accompanied by a carefully selected staff, he has arrived in the colony, and has commenced an examination of the country through which the contemplated line would pass.

The Bombay, Baroda, and Central India Railway Company.—The East India Company have granted to the railway company the concession of the 183 miles from Surat to Bombay, by which the railway will extend from Ahmedabad, passing through a district known as the Garden of Western India; and as Bombay is the mart from which the Chinese empire chiefly derives its supply of cotton, the importance of the junction of Surat and the cotton-growing districts will be duly estimated. A considerable portion of the earthworks are in a very forward state; but, in the construction of railways in our Indian possessions, it is necessary that two years should elapse before the permanent way can be laid down, to prove that they can stand the test of the monsoons. The present roads in India are quite in a primitive state, and, from the rough manner the cotton is now conveyed to Bombay, considerable damage is done by mud and dust. The East India Company, for some reason, never in the first instance guarantee a sufficient sum, and, therefore, the proposed increase is not unexpected, as from the formation of the company it has always been announced that the line could not be completed for the original capital—£500,000; so that there is little doubt but the whole of the new shares will be taken up by the existing holders.

Madras.—Steady progress has been made in the work of construction throughout the line. The line as far as Vanienbady, 120 miles from Madras, will be completed by the end of this year, and to Salem by the middle of next year. Considerable progress has at the same time been made in the earthworks on the western divisions of the railway. The violence of the rains in the month of October last, and the very unusual height to which the floods rose in the country traversed by the section of the railway, which is already open from Madras to Vellare, were such as to test severely the stability of its bridges and earthworks; they withstood the trial most successfully, the damage sustained was of trifling extent, and the passenger trains continued to run the whole line. After an extended and careful examination of the intervening country, the company's engineers have succeeded in finding a line much more favourable than had been expected for the railway to Cuddapah from Madras. This line, it is understood, has been approved by the Government.

Great Southern of India Railway.—It is proposed to run from the southern part of Tuticorin, in the Madras Presidency, *viâ* Madura and Trichinopoly, through Tanjore to the part of Nagore, with an ultimate extension from Trichinopoly to the Madras line at Salem. The total length is 300 miles, but the first section, for which a guarantee is asked on a capital of £1,000,000, is from Trichinopoly to Nagore, a distance of about 70 miles.

Scinde.—The harbour of Kurrachee has been greatly improved during the past two years, the depth of water was not less than from 22 to 26 ft. The capabilities of the harbour and the great traffic of the district were in most encouraging circumstances. The discovery of coal near the railway was another important matter; and it was a first-class steam coal. The works on the railway would be vigorously proceeded with, and they would be finished within two years. The Punjab Railway would commence from Mooltan, and run on to Lahore. The length being 248 miles running through a level country without any deviation, and only two bridges.

TELEGRAPH ENGINEERING, &c.

The Turkish Government have authorised Mr. John Staniforth, Jun., to proceed to England for the purchase of the necessary material for the construction of a telegraphic line between Constantinople and Bussorah, at the head of the Turkish Gulf. The line will extend a distance of 1,700 miles, and will consist of two wires. The Turkish Government have been induced to adopt this course in the hope that the East India, or other company, might obtain the sanction of the English Government to lay down a submarine cable in the Persian Gulf, between Kurrachee and Bussorah, and so complete telegraphic communication between England and India.

Dutch Indies.—The Government has conceded to Mr. Gisborne the privilege of constructing telegraphic lines, and of working them for 99 years.

Persia.—Fernkh Khan has ordered from a Paris manufacturer the apparatus necessary for the establishment of an electric telegraph in Persia.

Calcutta and Madras.—A new line of telegraph has just been put up between these cities.

Atlantic Telegraph Company.—Experiments are now being carried on with a view to perfect the paying out machinery, and to make it as nearly as possible self-acting. Mr. Cyrus Field stays in England to take charge of the next expedition, which will be in the *Niagara* and *Agamemnon* as before. It is proposed to increase the length of the cable from 2,500 to 2,900.

Liverpool.—Mr. Gisborne has laid before the Committee Town Council a plan for establishing telegraphic communication between the different fire stations of the town. Estimated cost, with the wires under ground, £3,300; over the house tops, £700. Annual cost in either case, £200. The committee declined to entertain the plan.

Atlantic Telegraph Company.—400 miles of new cable are in course of manufacture, to supply the loss from the failure of the experiment last year, and 300 additional miles, which it has been resolved should be provided, so as to allow greater length of slack than was originally contemplated. The cost for these 300 miles is estimated at £30,000. The English and American Governments have respectively offered the use of the *Agamemnon* and *Niagara* for the operation of the present year; and it has been agreed that it will be desirable to join the cables in mid-ocean, instead of starting from either shore. Considerable modifications are to be made in the machinery.

South Australia.—During the summer of this year it was reported officially that the inter-colonial telegraph would be completed throughout the several colonies of New South Wales, Victoria, South Australia, Tasmania, &c., connecting all the principal towns and ports in those several colonies, and embracing an area of 2,000 miles of telegraph.

MILITARY ENGINEERING, &c.

The Royal Standard Iron Gun Foundry, recently erected in Woolwich Arsenal, commenced operations on Feb. 12th, in an experimental form, under the investigation of Lieutenant-Colonel Wilmot, R.A., superintendent of that department. A couple of the furnaces, each of which is capable of melting upwards of 12 tons of metal, sufficient to cast one of the heaviest guns employed in the service, were on that day set in motion, and towards evening the operations of casting took place. The huge piece of ordnance has since been lifted from the moulding-pit, and represents the rough cast of a 68-pounder, weighing 95 cwt. A couple of smaller guns were likewise cast, exhibiting, as far as could be judged, a most satisfactory result. After being planed and bored, these guns, it is understood, will be subjected to some extraordinary proofs, in order to determine the contemplated advantages of the establishment, as a check on the contract manufacturers.

MARINE ENGINEERING, SHIPBUILDING, &c.

Combined Steam.—We learn that the result of the experimental trip of the *Avon* to the Brazils, with Wethered's combined steam-engine, has been most satisfactory. Mr. Gribble, who was selected by the company to which the vessel belongs to test the merits of the invention, reports that the saving of fuel has averaged 25 per cent., whilst 1 knot per hour has been added to the speed of the vessel.

In the spring the Bavarian Steam Navigation Company will send their boats down to Vienna and Pesth.

Three Steamers are being built in Dutch dockyards for the Emperor of Japan.

Letters from St. Petersburg state that great activity prevails, not only in the Imperial Dockyards, but also in those belonging to private individuals, and in a short time Russian maritime commerce, not content with having the loss which it experienced of its vessels during the war repaired, will possess a much greater number of ships than before. It is well known that the Grand Duke Constantine devotes much attention to the development of this branch of the marine. Very recently he has granted permission for a vessel built on the stocks of the Grand Navigation Company, established at Uli, in Finland, to assume his name.

An Extraordinary Ship.—"The New York Journal of Commerce" states that Mr. J. J. Rink, architect and engineer, has drawn up plans of a stupendous "fortress war-ship," 480 ft. in length, with 300 guns, 640 battle galleries, 3,600 berths, and all the munitions of war in proportion. Its appearance would, no doubt, scare off the most audacious enemy without the necessity of firing a gun. The ship is further provided with stable accommodation for 300 horses, two lighthouses, three powder towers, two wrench rudders, made to operate in all directions, and so arranged as to be used in checking the speed of the ship, besides a variety of other appliances. This last is a desirable quality, as the inventor is sanguine that she will be propelled at the rate of 45 miles an hour. In addition to steam power, the ship will spread not less than 6,000 yards of canvas. Even a partial description of all the novelties introduced would occupy columns of space.

New York.—There are at present no vessels building here for the merchant service. The only ships in construction are the Russian frigate at Mr. Webb's yard, and a United States sloop of war, building under contract with Jacob Westervelt.

The British steamer *Progress*, Docke, arrived at Gibraltar on the 1st of February, from the eastward, under canvas, the fan of her screw having broken previous to her coming into the bay.

The Collins' Steamer "Adriatic," it is asserted, has been sold to the Russian Government for £200,000.

Dr. Livingston's Launch.—This launch has been built by Mr. John Laird, at his new shipbuilding works at Birkenhead, the material employed being the new homogeneous metal commonly called "steel plates," manufactured by Messrs. Shortridge, Howell, and Jessop, of Sheffield. The great advantage of using this description of plates is, that the same amount of strength is obtained as that found in the best iron plates of double the thickness, so that a vessel of a much lighter draft of water can be built to the removal of the obstacles which have hitherto been in the way of navigating shallow rivers. After having made a variety of experiments in working this homogeneous metal, Mr. Laird thought it might be most applicable for this purpose in the construction of vessels of adequate strength, with light draft of water. The launch has been built with great despatch, the order for its construction having been given only five or six weeks ago. For convenience of transhipment, it has been built in three sections, on a patent taken out by Mr. McGregor Laird, five or six years ago. The centre section contains the boiler and a single horizontal high-pressure engine, of 12 H.P., and the two end sections are fitted up for the accommodation of the persons engaged in the expedition. Each compartment is made secure with water-tight bulkheads. In the aft section is a neat deck-house, which will be comfortably furnished, and will have every necessary for securing ventilation. The vessel is a paddle steamer, her dimensions being—length, 75 ft.; breadth, 8 ft.; and depth, 3 ft. She will not draw more than 12 or 14 in. of water, so that she is expected to be able to navigate the shallowest part of the river. The boiler, as well as the hull of the launch, is made of these steel plates, which are only 3-16ths of an inch thick. The boiler has been proved to 160 lbs. pressure, though it will only be necessary to work up to 40 lbs. This, we believe, is the first application of this cheap steel to boat-building purposes. If it should answer, there can be little doubt that not only numerous vessels of a similar class will be built for the navigation of shallow rivers, but that it will also be applied to the construction of vessels of large burden.

The "Leviathan" Afloat.—On Sunday afternoon, Jan. 30th, the launch of the *Leviathan* was successfully accomplished. The tide ran with unusual swiftness, and as the flood relieved the weight upon the launching ways, some of the hydraulic machines were set to work for the last time, to push the monster as far as possible into the centre of the river. She moved easily, and with such a low rate of pressure, that a short time gave an advance of 80 in., which showed that more than half the cradles were quite pushed off the ways, and rested on the river bottom. At a quarter to two o'clock the men in the row-boats stationed alongside observed that she no longer rested on the cradles, that she was, in fact, afloat; but, of course, the transition was so gradual that few were aware of it until the tugs began steaming a-head, and showed that at last she was fairly under way. She had moved, and was moving! The vessel moved at a quarter to two o'clock, was fairly afloat at half-past two, and at three o'clock swam tranquilly and majestically at her appointed mooring on the Surrey side of the river, off Deptford Dockyard. Her draught of water when moored was 16½ ft. aft, and 14 ft. forwards; and at the present moorings she will, at the lowest tide, have 19 ft. of water under her keel.

Annexed is the report of Mr. Brunel, the Engineer:—

"The consequences resulting from the launch of the ship, and the consideration of the steps to be taken now that that operation has been effected, are all so much more important to those interested in this undertaking than any description of the mechanical difficulties which had to be contended with, or of the means by which they were overcome, that I shall defer to some period when I shall myself have more leisure, any description of the 'launch.'

"It is sufficient now that you should know, in addition to the notorious fact of the vessel being afloat, that in the operation not the slightest alteration of form has taken place, or the slighest injury of any sort been sustained; that the ship is perfectly tight, and floats as nearly as possible with the draught and trim previously calculated. The next important question to all interested in the undertaking, and the last before the trial of the performance of the ship and engines, is now the time and cost required for completion ready for sea, and, with the concurrence of the directors, I propose to avoid as far as possible all risk of error in estimates formed upon these points (and, owing to the peculiarity of the circumstances, the novelty of much that has to be done in the fitting up of such a vessel, and the difficulty that always attends the making of calculations upon remnants of half-finished work, the risks of error in this case would be considerable). I propose to avoid these risks as much as possible by obtaining conditional contracts for the completion of all, or nearly all that remains to be done, and upon which the further proceedings of the company with reference to capital can be securely based.

"The steps necessary to obtain these tenders will necessarily occupy some time, but such will be well spent if certainty in our calculations can be obtained.

"I trust that an adjournment for one month will be sufficient to enable me to lay before you, for the information of the proprietors, such results as will practically attain the object in view. "I. K. BRUNEL."

IT is believed that the FIRST TRIP OF THE "LEVIATHAN" will be to Portland, in connection with the Grand Trunk Railway of Canada.

THE *Edith Moore*, an East Indiaman, of 1,430 tons register, and one of the largest vessels ever built in Liverpool, has just been launched from the yard of Mr. W. C. Miller, Toxteth Dock.

THE MELBOURNE CHAMBER OF COMMERCE has presented a protest to the Post-master-General, in reference to the irregularities of the mail service, and a detail is given of the past irregularities, from which it appears that, instead of six full-power steam-vessels between Suez and Sydney, there have never been more than four at one time, and for the greater part of the period only three.

COATING IRON SHIPS.—Mr. E. B. Olofson, of Cologne, proposes, in painting iron ships, to employ rich crystal plumbago, reduced to powder, and heated in metal pots, with one-third its weight of boiled linseed oil, until the colour changes from black to grey. A little sulphur is sometimes added, mixed with from 4 to 8 per cent. of a compound of powdered white marble, ground in linseed oil. For coarser pigments, anthracite is employed instead of plumbago. Iron is coated with it to prevent oxidation.

THE "IMPERADOR" AND "IMPERATRIZ," screw steamers, built by Mr. John Laird, for the South American and General Steam Navigation Company, and particulars of which have already appeared in THE ARTIZAN for 1855, p. 17, have been employed by the Government in taking troops to the East, and have made very successful runs. The *Imperador* made the entire run, from England to Hong Kong, in 77 days. The *Imperatriz* left England the same day, but having to call at the Cape, was a few days longer on the passage.

WOOLWICH DOCKYARD, FEB. 13.—The dimensions of the *Challenger* are similar to those of the *Scout, Pearl, Scylla*, and *Charybdis*, recently built at Woolwich and Chatham Dockyards, on a new principle, to carry an armament of 21 guns. The *Challenger* is, moreover, provided with an additional deck. Her principal dimensions are the following:—Length between the perpendiculars, 200 ft.; length of the keel for tonnage, 171 ft. 9⅝ in.; breadth extreme, 40 ft. 4 in.; breadth for tonnage, 40 ft.; breadth moulded, 39 ft. 4 in.; depth in hold, 22 ft. 8 in.; burden in tons, 1,462 21-94ths. Immediately after the launch the *Challenger* will be brought into the outer basin, to be fitted with a couple of engines of 400 H.P. Her battery will consist of twenty 8-in. guns, of 65 cwt., and one pivot 68-pounder, of 95 cwt., carried forward or aft, as may be convenient. The propeller is designed so as to be lifted by the spanker boom.

AN AIR FOG-SIGNAL, the invention of Admiral Taylor, has been placed upon the *Rhadamanthus* transport store ship. There are on the top of the instrument five whistles, which can be heard for miles.

ADMIRAL SIR GEORGE SARTORIUS has been deputed by the Portuguese Government to order a number of 300 H.P. engines from Messrs. Humphrys, Tennant, and Dykes.

LONDON, HARWICH, AND CONTINENTAL STEAM PACKET COMPANY.—A call of £10 per share has been made in this unfortunate concern.

AN ENGINEER OF A SCREW STEAMER has lost his life through suffocation, having taken a bucket of burning coals unto his berth and gone to sleep.

A NEW LIFE BOAT has been built by Messrs. Forrest, of Limehouse. The peculiar characteristics of this boat are its buoyancy and capacity of righting itself when capsized, and when filled with water from heavy seas, of self-discharging the entire body in twenty or twenty-five seconds. This advantage is obtained by means of six valves fixed at the bottom of the boat, which let out water but do not let it in.

THE COAST GUARD SQUADRON, hitherto consisting of mere hulks, is being replaced by effective auxiliary screw line of battle ships.

The firm of C. MITCHELL AND CO., Low Walker, Newcastle-on-Tyne, iron ship builders, has dissolved partnership.

GREENOCK, February 6.—This day the *Bremen*, a handsome screw-steamer, was launched from the building yard of Messrs. Caird and Co., of the following dimensions:—Length over all, 350 feet; breadth, 40 ft. 6. in.; depth of hold, 33 ft. 6 in.: tonnage, 2,600. Messrs. Caird and Co., are also to fit her up with a pair of direct-acting engines of 700 H.P.

BUILDING SHIPS.—This improvement consists in preventing the vibration of the sides of the ship, and the consequent leakage at the keel by arranging, diagonally, two rods and braces in opposite directions, from the keel to the top side of the ship; the said braces and rods bearing against strong knees or shoes, which securely tie the timbers of the keel together. We regard this as a good arrangement, which ought to be adopted in every large steamer. It is the invention of John Reeves, of Brooklyn.—*New York Scientific American.*

THE PACIFIC STEAM NAVIGATION COMPANY'S STEAMER *Vaddivia* has been lost.

RAPID TRANSFORMATION OF THE FRENCH SAILING NAVY INTO STEAMERS.—France (which during the War in the Crimea possessed only nine steam-ships of the line) will, in the course of the present year, have afloat twenty-four steam-ships of the same class, of which nine are of the greatest speed, and fifteen screw-steamers.

At the meeting of the ORIENTAL INLAND STEAM NAVIGATION COMPANY, Feb. 19th, it was announced that the directors have twelve vessels (two steamers and trains of barges), far advanced towards completion, and which it is expected will be ready for departure to India in April. The contract price of these vessels is £25,700. The directors have been in negotiation with the East India Company, and it is believed that the subvention may be increased from £5,000 to £10,000 a year; but a decision has not yet been arrived at. The post of resident engineer has been filled up by the appointment of Mr. Leys, late resident engineer of the Pacific Steam Company at Panama.

SHEERNESS, FEBRUARY 17.—The new screw steamship *Meeanee*, of 80 guns, proceeded on a trial trip of her machinery. She left the garrison point at 10·20 a.m., proceeded down to the Middle Light vessel in the Swin, and on her return steamed up Sea Reach, and returned into harbour at 4·35 p.m. on the same day. The mean speed given by patent logs was 10½ knots per hour, her engines making 63 revolutions per minute, with 20 lb. of steam; vacuum, 26½; screw, 19 ft. pitch, and 17 ft. diameter. The trial was satisfactory in every respect.

HARBOURS, DOCKS, CANALS, &c.

HARBOURS OF REFUGE.—The Government are not indisposed to make Great Yarmouth, on the Norfolk coast, a subsidiary harbour of refuge, at an outlay of £40,000 or £50,000, if the practicability of the proceeding can be demonstrated on scientific evidence.

CARDIFF DOCK EXTENSIONS.—The New East Bute dock has now been opened its entire length. The bank of earth which separated the portion first used from the second has been nearly removed, and the water allowed to run into the extension; the whole forming a lake of water 3,000 ft. in length, and from 300 ft. to 500 ft. in width. Vessels have entered, and the steam dredging machine is actively at work.

HOLYHEAD NEW HARBOUR.—The destruction of the staging lately erected for the construction of a round head on the north breakwater has, during the late gale, been fearful. The formidable mass of piles gave way to the terrific fierceness of the gale, and about 70,000 ft. of timber were carried away, and are now strewn along the coast below Penrhos. Six out of seven turntables, and thirty-three of the strong iron waggons, laden with stone, placed on the top for steadying the timber, were plunged into the sea.

NEW GRAVING DOCK AT MEADOWSIDE, PARTICK, GLASGOW.—The malleable iron gates are 70 tons weight, the sockets for which are formed in immense blocks of granite. The basin contains nearly an acre of surface space, and along with the wharves at the sides of the Clyde and Kelvin, affords about 1,200 lineal feet of quay surface for the accommodation of vessels. Two large jib cranes have been set upon the wharves of the basin, each capable of lifting 17 tons, and a steam crane capable of lifting 60 tons of dead weight. The dock is 500 ft. in length inside of the gates. The width on the sole of the dock, or floor, is 50 ft.; at the summit of the walls it is 80 ft.: and the entrance will permit the passage of a vessel of 56 ft. beam and drawing 17 ft. water. The pumping machinery for removing the water from the dock is of the most massive description; the engine and the pumps are in one piece, seated on the top of the masonry of the well, the bottom of which is 6 ft. under the lowest part of the dock; the engine is 150 horse power, working two pumps, each 50 in. diameter and 5 ft. stroke. These pumps are capable of emptying the dock in two hours' time. Besides this large engine, there is a smaller engine for driving the machinery connected with the dock, and pumping the leakage and surface water.

LIVERPOOL DOCK AND HARBOUR BOARD.—No new dockwork is to be commenced at the north end until the Birkenhead docks are completed. The power may be obtained to raise money to complete the new large dock and basin north of the Huskisson dock, and to extend the river-wall, as required by the Admiralty, for the protection of the navigation of the Mersey. Power is also to be obtained for raising money to be applied for the construction of cranes, and the laying down of railways to facilitate the working of the present docks.

JARROW DOCKS.—The works are making satisfactory progress. It is expected that the masonwork will be finished in about two months, and that the water will be let into the Great Dock in the autumn. The shipping jetties are in a forward state, and some of the spouts are finished. The railways are in a forward state. The standage will include 21 miles of single line. The 60 ft. entrance is finished, and the other gates are in a forward state. The contracts for the whole of the hydraulic machinery to open and shut the great gates have been let to Messrs. Armstrong and Co., of the Elswick works, for £4,800. There will be ample accommodation for large steam ships.

GREENOCK, FEBRUARY 6.—Six offers had been given in for erecting the new shed at the Victoria harbour, and the work had fallen into the hands of Mr. Stewart Allison, who was the lowest offerer, and that Mr. Bernard had been the successful offerer for executing the pileage at the steamboat quays.

PEMBROKE.—The Board of Admiralty have entrusted to Mr. William Williams, the contractor for the battery built by the War Department, at Dale, the contract for dredging the mud opposite the Royal Dockyard, Pembroke Dock; and he is having barges built on a plan designed by himself for the purpose, and will commence operations immediately. The works are to be carried on under the supervision of Mr. Edward Miller, clerk of works to the Board of Admiralty.

PROJECTS FOR THE IMPROVEMENT OF THE MOUTHS OF THE DANUBE.—There are three, or, more properly, four, first—that of Mr. Hartley, the engineer of the Commission; then that of the Austrian engineer, M. Wex, both advocating the preference of the St. George; that of the Prussian engineer, sent out last summer, who is in favour of the Sulina; and lastly, a project submitted by Captain Spratt, R.N., suggesting the Ochakoff Mouth of the Kiliabranch.

VENICE.—The operations for deepening the canals of Spignone have been so successful, that large vessels can enter it at low water without difficulty or danger, and at any time of the day or night. Dredging is carried on with great energy on the sandbank of Rochetta. Before the end of the year, the largest war frigates will be able to cast anchor before the Place of St. Mark.

SOUTHAMPTON DOCK COMPANY.—An extension of the works is proposed.

GAS ENGINEERING, &c.

SOAPSTONE GAS BURNERS.—In gas burners made of iron or brass, the heat of the flame expands the metal and enlarges the opening, causing some waste of gas, and besides, the metal is liable to corrode. To obviate these evils, M. Schwarz, of Nuremberg, has lately manufactured gas burners from soapstone (steatite). This stone is cut up into small four-sided slabs put into hermetically sealed cases, and exposed to a slow fire until it becomes red hot. Great care is exercised in thus roasting the stone, because if quickly heated, it will rupture by the sudden expansion of small particles of moisture in it. The steatite slabs are exposed to this heat for about two hours, slowly cooled, and are then easily turned to the proper shape in a lathe. After this, they are boiled in oil until they acquire a deep brown colour, when they are taken out, dried, and made to assume a beautiful polish by simply rubbing them with a woollen rag. Liebig gives these burners a very high character, and advises all chemists to employ them in their laboratories.

KEYNSHAM.—Messrs. Atkins and Son, of Chepstow, have just completed the erection of new gas works capable of producing 24,000 cubic ft. in twenty-four hours. The ovens are on Clift's patent.

LONGFORD (Ireland) has been lighted with gas.

NEW WORKS are about to be commenced at Bray, county Wicklow, and Dublin.

THE COPIAPO GAS COMPANY have received a complete certificate of registration under the Limited Liability Act.

LIGHTING STREET LAMPS by Electricity. Messrs. Keogh have patented a new system.

AGRICULTURAL ENGINEERING, &c.

THE NORFOLK AGRICULTURAL SOCIETY has resolved that all money prizes for implements shall be given to collections, and not to individual implements.

AUSTRALIAN AGRICULTURAL COMPANY.—A dividend has been declared of £1 per share. The chairman, in alluding to the various proposed rail and tram ways, for the development of the resources of the Company, observed that the directors are well disposed to assist independent parties in the construction of such works, but were unanimously of opinion that, before embarking capital in a new project, their existing operations should be brought to a successful issue. The machinery sent out for the coal mines has turned out defective, and the loss from this cause will be about £2,500. It was purchased from the British Iron Company.

A COUNTY AGRICULTURAL SOCIETY has been established in Essex.

THE SUFFOLK AGRICULTURAL SOCIETY will hold their annual exhibition at Bury St. Edmund's, on Wednesday, July 7. It was proposed to award a premium of £30 for the best application of steam to cultivation, but the proposition was negatived on the ground that the exhibitors objected to the prize system.

BOILERS, FURNACES, SMOKE PREVENTION, &c.

PREVENTING INCRUSTATION IN BOILERS.—R. McCafferty, of Lancaster, Pa., patented a new process for this purpose on the 14th April, 1857. It consists in putting half a pound of black gum catechu in a boiler of 100 H.P., until the water becomes the colour of pale brandy, and during the week the water is kept as nearly that colour as possible.

Boiler Explosion.—Llanelly and Llandilo Railway, which runs into the South Wales line at the former place. The engine was an old one. It was waiting, with steam up, at the Garnant station for a train, and several passengers were on the platform. The stoker had just put on a fresh supply of coals, when suddenly, without any previous warning, the boiler burst. The dome of the engine, and some iron attached, weighing nearly half a ton, were blown to a distance of nearly 150 yards. Three persons were killed.

Smoke Prevention.—The premium of £500, offered by the Steam Colliers' Association, in the North of England, for the prevention of smoke during the combustion of Hartley coals in steam boilers, has been awarded to Mr. C. Wye Williams, of Liverpool.

Among the improvements which have recently been adopted in Woolwich Arsenal are smoke-burning furnaces, erected by Mr. Armstrong, civil engineer, many years in the employ of Government. One of these, termed a Reverberative Forge Furnace, has been for some months past in use in the Royal carriage department smithery, experimentally, so as to test its power and efficiency in remedying the smoke nuisance, now become so formidable, in consequence of the newly-erected establishments having commenced operations. Proof being given of its favourable results in materially diminishing the amount of smoke, in accordance with the clause contained in the Act of Parliament, it was at the same time ascertained that an economy of about 4 per cent. in the use of fuel was an additional advantage. A second furnace on the same principle has been ordered to be constructed in the Royal gun factory department, and is nearly ready for trial. The system of consuming the smoke is carried out by means of an ordinary brick furnace, supplied with small valves, or air channels, by which the air is introduced into a series of heated tubes along the roof. By this expedient the smoke becomes inflamed, and little more than a mere vapour appears at the top of the chimney. Unlike, however, the ordinary furnace, the fire is fed from a door near the roof. A second furnace, patented by Major Vandeleur, R.A., has also been erected in the same department, having similar pretensions to the above, but constructed with certain internal arrangements, so as to cause the smoke to redescend from the roof and pass through the body of the fire.

Using Coke in Smithies.—The Liverpool Smoke Inspector has made a series of experiments, which proved that coke might be advantageously used in smithies in place of slack. The inspector has also induced the men at the Northumberland Works to use coke, and they found that it was better to work with than slack, while its use also put a stop to the constant emission of dense smoke.

APPLIED CHEMISTRY, &c.

A New Discolorising Agent.—M. Ch. Mène, chemist, of the Metallurgical Establishment at Creuzot, has recently made various experiments, which seem to prove that hydrated alumina may be substituted for animal charcoal for the discoloration of liquids. He prepared hydrated alumina by decomposing alum by carbonate of soda; then, filtering and washing this alumina, mixed in excess with different colouring matters in ebullition, tincture of litmus or carmine, syrups, and molasses, he found it to give rise to coloured lakes, which fall to the bottom, while the liquor becomes entirely colourless. For discoloring the syrups of sugar they use in the establishments large tubes of sheet iron, capable of containing from $1\frac{1}{2}$ to 2 tons of animal charcoal. The liquid brought into contact with this charcoal percolates it very slowly. If the charcoal were replaced by alumina, completely insoluble, and tasteless, the operation of discoloration would be reduced to a simple cooking, followed by a filtering through a simple cloth. 15 grammes of alumina replaced 250 grammes of animal charcoal in the discoloration of a quart of water, coloured by 10 grammes of litmus. For a solution of sugar, coloured by molasses, 7 grammes of alumina were equivalent to 125 of animal charcoal. The revivification of the alumina will, moreover, be much easier than that of the charcoal.

Waterproof Paper for Packages.—Take 24 oz. of alum and 4 oz. of white soap, and dissolve them in 2 lbs. of water; into another vessel dissolve 2 oz. of gum-arabic and 6 oz. of glue, in the same quantity of water as the former, and add the two solutions together, which is now to be kept warm, and the paper intended to be made waterproof dipped into it, passed between rollers, and dried, or, without the use of rollers, the paper may be suspended until it is perfectly dripped, and then dried. The alum, soap, glue, and gum, form a kind of artificial leather, which protects the surface of the paper from the action of water, and also renders it somewhat fireproof.

Starch from Horse Chestnuts.—Considerable quantities of horse chestnuts are wanted from our departments, at a price equal to that which the starch factories paid for potatoes last year. These fruits are destined for a factory at Nanterre, to be converted into starch. We have already remarked that there would be a great advantage in replacing the starch derived from the grains by a starch extracted from an otherwise useless fruit. The horse chestnut is acclimated everywhere, grows rapidly, and on the most sterile soils; is not attacked by insects; and now that an excellent starch is extracted from its fruit, there will be a certain profit in multiplying the tree, which is one of the most beautiful in Europe, along our roads, promenades, and public places.—*Cosmos.*

Process for Printing from Veneers.—A process of veneering by transfer is mentioned with approval in the French journals. The sheets of veneer, or inlaying to be copied, is to be exposed for a few minutes to the vapour of hydrochloric acid. This novel plate is then laid upon calico or paper, and impressions struck off with a printing press. Heat is to be applied immediately after the sheet is printed, when a perfect impression of all the marks, figures, and convoluted lines of the veneer is said to be instantaneously produced. The process, it is affirmed, may be repeated for an almost indefinite number of times. The designs thus produced are said all to exhibit a general wood-like tint, most natural when oak, walnut, maple, and the light-coloured woods have been employed.

Spirit for Blowpipe Lamp.—Mr. F. Tisani suggests the use of a mixture of six parts of alcohol, sp. gr. 0·848, with one part oil of turpentine, and a few drops of ether. Wood spirit may be used instead of the alcohol, and of it four parts will suffice. The mixture must be perfectly clear, for the undissolved globules of turpentine cause the lamp to smoke.

Clarifying Sugar by Soap.—This new process, invented by Mr. Garcia, a sugar refiner, late of Louisiana, was brought under the notice of the Academy of Sciences, at Paris, by M. Basset, a few days ago. It is founded on the well-known property of lime, which combines with fatty substances, whether free or transformed, into alkaline soap. When the saccharate of lime is brought into contact with a solution of soap of soda, the sugar is set at liberty, the lime combines with the acid of the soap, and the soda remains in dissolution in the liquid. When the clarification has been effected with an excess of lime, and the liquid has been skimmed a first time, it must be allowed to cool to below 104 deg. Fahr., and the solution of soap is then poured in, the liquid being gently stirred all the while. When the whole has been well incorporated, it is brought again to the boiling point, after which the temperature is suddenly lowered again by the suppression of the steam current, and the new scum is removed. The latter consists entirely of a calcareous soap, which, in rising to the surface, has carried away with it all the impurities and extraneous substances contained in the liquid, and has an excellent taste. This process requires no new apparatus, increases the beauty of the sugar, yields more, and is, consequently, more economical.

Arsenic in Paperhangings.—Dr. Alfred Swaine Taylor, in his evidence before the Select Committee of the House of Lords last Session, on the Sale of Poisons Bill, after pointing out that arsenic was much used in several manufactures—such as in the manufacture of glass, especially opal glass, of shot, in the steeping of grain, and in killing the fly in sheep—states that the largest quantity of arsenic used in this country is used in the manufacture of paper for covering walls. He considered it very injurious both to those living in a house papered with this article, as well as to those employed in the manufacture.

MINES, METALLURGY, &c.

Lake Superior Copper Mines.—The amount of copper shipped from Ontonagon, by the various mines of that district, during the season of navigation of 1856 and 1857, was upwards of 3,280 tons, the estimated value of which is not less than 1,000,000 dols.

Ireland.—It is proposed to work three beds of silex, in a sett leased to Mr. Deering, C.E., at Rostellan, Cork Harbour. Silex is substituted for ground flint and Cornish stone in the manufacture of porcelain and earthenware.

Advices from Australia to December 15 state that a staff of Prussian mining engineers are making a tour through the mining districts of the Colony.

Loss of Lead and Silver Ores in Washing.—M. Fournet calls attention to the loss arising from the difficulty of thoroughly wetting the ore at once, and the consequent fact that the air entangled in the powder causes a considerable quantity to float and pass off with the water. This is seen in pouring water over any powder—*e.g.*, magnesia. He shows that this effect takes place with lead and silver ores in pure and salt water, but not in oil or in alcohol. He proposes no practical remedy.—*Comptes Rendus.*

Strengthening Electro Magnets.—M. Schefzik, Engineer of the Imperial Telegraphs (Austria), has endeavoured to remedy the inconveniences arising from the inconsiderable diameter of the copper wire, with which the core of iron has hitherto been wrapped, when powerful electro magnetic effects were to be obtained. He has perfectly succeeded by wrapping the core with ribbons of copper, presenting their edges to the core. This new apparatus occupies much less space than an apparatus with thick cores, and produces powerful effects by means of a galvanic current developed by a battery of few, but large elements.—*Geological Institute of Vienna* (*l'Institut*).

Oreide—A New Brass.—M.M. Meurier and Vallent, of Paris, have succeeded in making an alloy which imitates gold sufficiently near to merit the name Oréide. The properties are as follow:—Pure copper, 100 parts by weight; zinc, 17; magnesia 6; sal ammoniac, 3·6; quick lime, 1·80; tartar of commerce, 9. The copper is first melted, then the magnesia, sal ammoniac, lime, and tartar in powder, little by little; the crucible is briskly stirred for about half an hour, so as to mix thoroughly, and then the zine is added in small grains by throwing it on the surface, and stirring until it is entirely fused, the crucible is then covered and fusion maintained for about 35 minutes; the crucible is then uncovered, skimmed carefully, and the alloy cast in a mould of damp sand or metal. The oréide melts at a temperature low enough to allow its application to all kinds of ornamentation; it has a fine grain, is malleable, and capable of taking the most brilliant polish. When after a time it becomes tarnished from oxidation, its brilliancy may be restored by a little acidulated water. If the zinc is replaced by tin the metal will be still more brilliant.—*Cosmos.*

Iron Sands in New Zealand.—The coast abounds with iron sands, such as the best iron is made of in Sweden; and the Colonial Government offer a reward £1,000 for the production of the first 100 tons of merchantable wrought or cast iron, made from this sand.

NOTICES TO CORRESPONDENTS.

H. B. F. (Rio).—The Mr. Vignoles to whom you refer is Mr. Charles Vignoles, C.E., who built the Kieff Suspension Bridge, erected across the Dnieper in Russia. We believe he has visited Brazil for the purpose of making some railway surveys; and although we have on a former occasion given most of the dimensions of the Kieff Bridge, we will comply with your request, as you may not have the opportunity of referring to the Numbers containing those particulars; the following are, therefore, the principal dimensions and particulars:—

Extreme length, 854 yards—(nearly half-a-mile), or .... (366 *Russian sagènes*—776 *French mètres.*)	2,562 feet
Extreme breadth, $17\frac{1}{2}$ yards, or .... ($7\frac{1}{2}$ *Russian sagènes*—16 *French mètres.*)	$52\frac{1}{2}$ „
Spans: Each of the four large openings, from centre to centre of the river suspension towers or piers	440 „
Spans: Each of the two side openings, from centre of the suspension tower to the face of the abutment	225 „
Spans: Swivel bridge opening, in the clear	50 „
Clear waterway at highest floods	2,140 „
Height of platform above ordinary summer water-line	30 „
Greatest rise of floods (after the melting of the snows in the spring) above the ordinary summer water level	20 „
Greatest depth of water in the channel at summer level	40 „
Ditto at highest floods	60 „
Extreme height from deepest river foundations to the top of caps of the suspension towers or piers	112 „
Breadth of the portals piercing the suspension towers	28 „
Height of ditto	35 „
Chord of chains of large openings, clear of piers	416 „
Versed sine of ditto	30 „
Total length of all the suspended platforms, clear of piers	2,090 „
Total weight of all the platforms and rods, clear of piers (48 lb. per square foot)	2,350 tons.
Weight of chains and pins, suspended clear of the piers	1,076 „
Total weight of the four chains and pins only (length of each chain, 2,280 feet)	1,578 „
Minimum sectional area of the four chains, excluding pins and overlaps	328 sq. in.
Total weight of iron of all kinds used in the works	3,500 tons.
Total quantity of timber used, including temporary works	500,000 c. ft.
Total quantity of masonry, brickwork, and concrete in the works ..	1,500,000 „
Proof load per available square foot of suspended platform	63 lbs.
Total proof load calculated to be laid on the bridge for testing	2,350 tons.
Actual load laid on the bridge for the test—60,000 cubic feet of sand—which, being much wetted by heavy rain during the test, weighed 1 cwt. per cubic foot, being equivalent to the weight of 50,000 infantry soldiers, or about	3,000 „
Total expenditure, about £432,000 sterling.	

The works were commenced in April, 1848, whilst the first stone was laid with great ceremony, September 9th, 1848, and the bridge was opened October 10th, 1853. The test load for the platform was nearly 60,000 cubic feet of wet sand, which was allowed to

remain several days. The chains are composed of links, each 12 feet long, weighing about $4\frac{1}{2}$ cwt., the breadth of each chain being equal to the thickness of eight of these links, placed side by side; and the total length of chain employed is about 3,500 yards, there being four principal openings, each of 440 feet, and two side openings, of 225 feet each: there is also an additional opening close to one of the shores for the passage of river craft—this is 50 feet wide, and is spanned by a swivel bridge. The width of the platform is about 52 feet, which is suspended by four chains, two on each side of the road; the carriage-way being 35 feet wide, and the footpath on each side projects outside of the chains.

The total weight of iron used in the construction of the bridge is stated to be about 3,500 tons. The suspension chains being made by the late firm of Fox, Henderson, and Co., the other iron-work by Messrs. Musgrove, of Bolton.

Q.—The Abbé Moigno, of Paris, described a series of experiments which were made by him for the purpose of determining the practical value of super-heating steam. The experiments referred to were made upon the plan of Wethered. Unfortunately, the learned Abbé's very rapid delivery, added to its being in the French language, rendered it almost impossible to follow him; and many of the members of Section G of the British Association, who were present, were unable to realise the advantages insisted upon as pertaining to the Honourable John Wethered's system of super-heating steam, but the following is an extract from the statement made by the Abbé Moigno:—

Kind of Steam.	Pressure.	Temperature.	Revolutions.	Consumption of Coal.	Coal consumed per revolution.
	Atmosphrs.			Kilos.	Grammes.
Ordinary	2·	128°	7,892	151	19·2
Surcharged ...	2·4	160°	7,886	99	12·
Combined	2·3	157°	7,886	72	9·

The first horizontal line relates to ordinary steam; the second relates to steam surcharged with heat, the bottom line gives the result of the combinations of two steams when brought together and mixed at the cylinder; the third vertical column shows the number of revolutions to have been the same—namely, 7,886 with the surcharged steam, and with the combined steam respectively, whilst with the ordinary steam, 7,892 revolutions were recorded, being six more than in the other two experiments. Thus, whilst the consumption of coal was 151 kilos., with ordinary steam for 7,892 revolutions, the number of revolutions being 7,886 with surcharged steam, at the temperature and pressure given, exhibits a consumption of 99 kilos. only, whilst the combined steam, at a slightly reduced pressure and temperature gave a consumption of 72 kilos. of coal for 7,886 revolutions. The coal consumption reduced to grammes *per revolution* shows respectively 19·2, 12·0, and 9·0, as the equivalents. Now, if these experiments were properly conducted and carefully recorded, and it can be shown that no prejudicial action ensued from the use of super-heated steam, and, indeed, that no practical drawbacks of equal or greater magnitude and importance, as compared with the economy of fuel, the system of super-heating exhibits advantages which speak for themselves; and although we are loth to express an opinion unfavourable to the employment of super-heated steam under circumstances where it would be of the greatest advantage, yet we are unable to record any thoroughly satisfactory experiments of a practical character which have been successfully made, or which have resulted in the daily use of this system.

We believe we are correct in stating that a series of experiments have, for some time past, been in progress at one of Her Majesty's Dockyards, for the purpose of practically testing the question, although we understand that the plan of the Hon. John Wethered is not the one which is being tried.

When anything in the shape of a satisfactory result is announced, we will publish it.

C. Pearcy.—By reference to an answer given to "Radix" in the Notices to Correspondents for February, you will find one of your questions answered. With reference to the others, we cannot do better than refer you to the very able work, by Mr. Daniel Kinnear Clark, C.E., on "Railway Machinery," where you will find, under Section 2, "Physiology of the Locomotive," the link motion is treated of in Chapters 3 and 4, pp. 39—53, as it would be an extravagant expenditure of space were we to cite in our columns what Mr. Clark in his work says upon the subject; and, moreover, it would be unfair to our subscribers, considering the very limited space we have at our disposal each month for replying to inquiries.

Take our advice, and buy Mr. Clark's book. You will find it very useful.

A. B., *ex.*—We regret we have not yet been able to obtain for you, and for other correspondents, the information as to the tangent wheel referred to.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 8th December, 1857.

3038. W. J. Ward, Chorlton-on-Medlock, Manchester—Dyeing and printing textile fabrics and materials, and in apparatus connected therewith.

Dated 19th December, 1857.

3117. T. Hart, jun., and A. Jones, Blackburn—Improvements in looms.

Dated 21st December, 1857.

3127. W. Thrift and A. High, Stepney—Improved self-acting ship's water closet.

Dated 23rd December, 1857.

3148. W. Nunn, Hackney, Middlesex—Stereoscopic apparatus.

Dated 24th December, 1857.

3160. G. W. Hart, 5, Osborne-terrace, Southsea—Locks.

Dated 28th December, 1857.

3174. H. Desmoutis, Paris—New metallic alloys.

Dated 30th December, 1857.

3184 J. Blake and R. D. Kay, Accerington—Apparatus for reducing and regulating the quantity, force, or pressure of steam.

3192. J. Clinton, 35, Percy-street, Middlesex—Improvements in wind musical instruments played by the mouth, and in mandrils used in such manufacture.

3195. H. Hanson, Stockport—Manufacture and finish of cotton-band, twine, band, rope, cordage, and other fibrous substances, and in machinery or apparatus employed therein.

3196. P. W. Barlow, 26, Great George-street, Westminster—Permanent way of railways.

3197. A. J. M. Ramar, 49, Broad-st., Golden-sq.,—Ornamental and portable fountains.

3198. G. Wilson, Sheffield—Furnaces or fire-places of steam boilers.

3199. W. Middleship, Grove-ter., South-grove, Mile end—Machinery for obtaining motive power.

3200. J. Long, Gorleston, Yarmouth, Norfolk—Construction of sewers, and in the means of discharging the contents thereof.

Dated 1st January, 1858.

1. J. Henry, Friday-street—Weaving fabrics for ladies' dresses and petticoats.
3. L. J. A. Brun, Paris—Instruments for measuring angles, applicable to nautical and other purposes.
4. G. Gorle, Handsworth—A service-box for water-closets.
5. A. Parkes and H. Parkes, Birmingham—Manufacture of rods, wire, nails, and tubes.
6. J. W. Clare, Surrey-sq.—Steam engines and boilers, part of which improvement is applicable to furnaces.
7. J. H. Johnson, 47, Lincoln's-inn-fields—Penholders, pencil cases, and other articles sliding in cases of a like nature.

Dated 2nd January, 1858.

8. R. Harvey, Glasgow—Steam hammers.
9. A. Slate, Adelaide-road, Haverstock-hill—Apparatus for supplying fuel to blast furnaces.

Dated 4th January, 1858.

10. T. Scott, Drummond-street, Euston-square—Cleaning, separating, and mixing seeds, and apparatus.
11. E. T. Tillam, St. Mary's Hospital, Paddington—Apparatus for ventilating buildings.
12. F. Walton, Haughton Dale-mills, Manchester—Manufacture of sheets or plates made of plastic compositions and other materials, and in the application thereof, either alone or in combination with other substances.
13. E. H. Kiddle, Broad-street, Lambeth—Smut machines.

Dated 5th January, 1858.

14. J. Ellis and J. H. Ellis, Leicester—Machinery for subdividing masses of rock and minerals.
15. J. N. W. Twigg, Coventry, and W. Adkins, Birmingham—Self-acting railway-breaks.
16. J. Leeming and J. C. Ramsden, Bradford—Looms for weaving.
18. G. E. Dering, Lockleys, Hertford — Electric telegraphs, and manufacture of insulated wire and cables.

Dated 6th January, 1858.

19. T. F. Cocker, Sheffield—Manufacture of wire applicable to umbrellas and parasols, and to articles of dress.
20. R. A. Brooman, 166, Fleet-street—Lock buckle.
21. H. C. Jennings, 8, Great Tower-street—Application of tannin or tannic acid.
22. J. D. Malcolm, 47, Leicester-square—Apparatus for ornamenting fabrics and other surfaces.

Dated 7th January, 1858.

23. M. L. J. Lavater, 23, Holywell-lane, Shoreditch—The application of the principle of exhausting air, as used in plate holders, breast pumps for pegs.
25. C. A. Thiry, Paris—Improved oyster holder.
26. F. P. Cappon, Marans, France—Self-acting pads for doors, shutters, windows, or other similar shuttings.
27. J. Reilly, jun., Manchester—Improvements in chairs and seats.
28. E. Graham, 14, Noel-st., River-terrace, Islington—Apparatus for threading needles.
29. R. and J. Philp, Norwood House, Cheltenham—Propellers for propelling ships, boats, and other vessels in water.
30. E. Maw, Doncaster Iron works, Cheshire—Construction of metallic bedsteads, and other surfaces to sit or recline on.
31. G. J. D. W. De Winton, Junior United Service Club, Charles-street, St. James's, Westminster—Copying apparatus.

Dated 8th January, 1858.

32. S. Lees, Salford—Manufacture of mineral oil.
33. H. Raymond, Bristol—Propelling ships or vessels.
34. P. Soames and J. C. Evans, Morden Iron Works, East Greenwich—Steam cranes.
35. R. A. Brooman, 166, Fleet-street—A method of, and apparatus for, teaching music and arithmetic.
36. H. Atkins, Nottingham—Producing scarfs, neck-ties, and other articles from the warp machine.
37. T. Greenwood and J. Batley, Leeds—Machinery for heckling flax and other fibrous materials.

Dated 9th January, 1858.

38. R. Brown, Liverpool—Water-closets.
39. W. Church, Birmingham—Measuring rules, compasses, and in the machinery.
40. T. Rowell, Sunderland—Furnaces.
41. W. Parsons and J. Attree, Brighton—Measuring of water and other liquids, and an improved water and liquid meter.
42. J. A. M. Chaufour, Paris—Improvements in the construction of axle-boxes and axle-bearings.

Dated 11th January, 1858.

43. W. Tregaskis, 37, St. Andrew's-hill, Thames-street—Printing press.
44. T. Knowles, Hollingrove, Bury, and W. Ogilvie, Manchester—Looms.
45. I. Taylor, Stanford Rivers, Essex—Manufacturing metallic cylinders used in printing calico and other fabrics, and in imparting engravings to metallic cylinders used for such purposes.
46. W. Hartree, Lewisham-road—Furnaces or fireplaces.

Dated 12th January, 1858.

47. E. H. Bentall, Heybridge, near Maldon, Essex—Improved arrangement of portable gearing apparatus for the application of horse power, principally for driving various kinds of agricultural machines or implements.
48. A. F. E. Robert, Paris—Manufacture of curtains and hangings for walls and other places.
49. J. H. Johnson, 47, Lincoln's-inn-fields—Boilers and heating apparatus.

Dated 13th January, 1858.

50. G. C. Greenwell, Radstock, near Bath—Improved pigment.
51. C. Barlow, 89, Chancery-lane—Registering water meter.
52. G. W. Muir, Manchester—Warming and ventilating.
53. R. A. Brooman, 166, Fleet-st.—Preparation of coal and other fuel.
54. E. B. Bright, Liverpool—Communicating signals by electricity, and in the apparatuses employed therein.
55. P. Robertson, 1, Sun-court, Cornhill—Inkstands.
56. W. Parsons, Pratt-street, Old Lambeth—Apparatus for supplying water to, and for preventing explosions of steam-boilers.
57. C. E. Matson, Charles-st., Deptford—Roughing horses' shoes.
58. J. B. A. Couder, Paris—Shawls.

Dated 14th January, 1858.

59. N. E. Jeanroy, Rue de l'Echiquier, Paris—Manufacture of net lace.
60. W. Woodcock and T. Blackburn, Sough, near Blackburn, and J. Smalley, Blackburn—Machinery for heating and circulating air, to be applied to all purposes where heating is required.
61. J. A. Manning, Inner Temple, Middlesex—Treatment of sewage and other polluted liquids.
62. J. Broadley, Saltaire, near Bradford—Apparatus used in weaving.
63. J. Stenson, Northampton—Manufacture of wrought iron.
64. H. Ingle, Shoe-lane—Printing machines.
65. W. Clark, 53, Chancery-lane—Improvements applicable to the paying out of submarine or submerged telegraph wires or cables.

Dated 15th January, 1858.

66. J. Varley, Albion Iron Works, Radcliffe—Steam engines.

67. C. Schinz, Camden, New Jersey, U.S.—Apparatus for manufacturing prussiate of potash.
68. J. Macintosh, Aberdeen—Articles of confectionary.
69. D. Bowlas, Reddish, Lancashire—Machinery for preparing and spinning cotton and other fibrous substances.

Dated 16th January, 1858.

71. R. J. Badge, Newton-heath, near Manchester—Machinery for drawing or extracting spikes or trenails from railway sleepers and chairs, and other similar purposes.
72. J. Austin, Millisle Mills, Donaghadee, Ireland—Machinery for ploughing or cultivating land.
73. R. Archibald, Devon-vale, Tillicoultry, N.B.—Treatment or preparation of wool, and other fibrous materials for being spun.
74. G. Macbeth, Manchester—Improvement applicable to sewing machine.
75. F. Hyde, Glossop—Machinery for spinning, doubling, twisting, or throwing cotton, silk, wool, flax, and other fibrous substances.
76. E. Hills, Warsash, Southampton—Process for manufacturing sulphate of ammonia.
77. P. Robertson, Sun-court, Cornhill—Lamps.
78. C. A. de L. de la Brosse, Paris—Machinery for the manufacture of looped or knitted fabrics.
79. E. Rosa, Edinburgh, N.B.—Manufacture of dough and other plastic or porous substances.

Dated 18th January, 1858.

80. R. A. Brooman, 166, Fleet-street—Pipes and tubes.

Dated 19th January, 1858.

81. T. Hamilton and J. Hamilton, Glasgow—Holders or bobbins for holding or containing yarn or thread, and in turning, cutting, shaping, and reducing wood and other substances.
82. A. Walker and T. Walker, Shotts, Lanark, N.B.—Treatment or preparation of moulds for casting metals.
83. E. Wilson, 9, Rainbow-terrace, Worcester—Pistons for steam engines driven by steam or any other elastic fluid, which improvements are also applicable to the pistons or plungers of pumps.
84. W. Waller, Uddingston, near Glasgow—Machinery for grinding, bruising, breaking, and cutting cereals, grasses, and other vegetable substances.
85. W. Waller, Uddingston, near Glasgow—Threshing machines, or machinery for thrashing and dressing grain.
86. V. De Tivoli, 67, Lower Thames-street—Omnibus.
87. P. S. Bruff, Ipswich—Construction of submerged tunnels.
88. C. G. A. Tremeschini, Vicenza, Venetian Lombardy—Mechanical arrangements for applying card board to the weaving of figured fabrics, and for arranging the card-board for this purpose.
89. B. B. Wells, Strand—Ordnance.
90. J. H. Johnson, 47, Lincoln's-inn-fields—Boxes and journals of carriage wheels and axles.
91. T. Pirie, Nether Kinmundy, Aberdeen, N.B.—Machinery for thrashing and separating grain.
92. P. Capon, Chancery-lane—Apparatus for binding together pamphlets, letters, music, and other loose documents or sheets.
93. O. V. Corvin, Alfred-pl., Alexander-sq., Brompton—Mode of inlaying or ornamenting in metals and other materials.

Dated 20th January, 1858.

94. C. N. Nixon, Ramsgate—Application of screw power, being applicable to steering apparatus, capstans, windlasses, cranes, winches and other mechanical purposes.
95. R. Martin, Glasgow—Apparatus for effecting th shipping of minerals in tidal situations.
96. T. Heppleston, Manchester—Improvements in machinery for winding yarns or threads.
97. W. Muir, Strangeways, Manchester—Stands for letter copying presses and other small machines.
99. J. Dyson, E. W. Shirt, and H. Shirt, Tinsley Works, near Sheffield—Spring for resisting sudden and continuous pressure.
100. C. Rishworth, Sheffield—Improved construction of spring for sustaining loads and moderating concussion.
101. R. A. Brooman, 166, Fleet-street—Preservation of animal and vegetable substances.
102. J. J. Russell, Wednesbury, Staffordshire—Apparatus used in the manufacture of welded tubes.
103. W. Conisbee, King-street, Queen-street, Southwark-bridge-road—Printing machines.
104. P. Robertson, 1, Sun-st., Cornhill—Manufacture of paints.

Dated 21st January, 1858.

105. J. H. Wheatley, 15, Jacob's-well, Barbican, City—Printing machines.
106. W. White, Adelaide-street, South Shields—Machinery for making moulds or matrices employed in casting metals.
107. T. Ivory, Edinburgh—Steam boilers.
109. J. Murdoch, 7, Staple-inn—Breaks for railway and other carriages.
110. P. Wilson, S. Northall, and T. James, Birmingbam—Locks and latches.
111. E. Rawlings, Birmingham, and J. Briden, Aston-juxta-Birmingham—Improved method of working stamps used for stamping or raising metals, and others ch like purposes.
112. H. Smith, Brierley Hill Iron Works, Dudley—Improvements in the manufacture of iron hurdles and fencing.
113. J. S. Brown, Cirencester—Mills for grinding corn or other substances.
114. W. Clark, 53, Chancery-lane—Lubricating apparatus.
115. H. Hermagis, Paris—Stereoscopes.

Dated 22nd January, 1858.

116. W. M. Raine, 34, Bucklersbury—Purifying and increasing the illuminating power of gas.
117. W. B. Haigh and J. Cheetham, Oldham—Valves for steam-engines and in superheating the steam.
118. J. Brown, Coventry—Looms.
119. J. Brown, Coventry—Jacquard machines.
120. W. Basford, Longport, Staffordshire—Improvements in kilns or ovens for burning or firing bricks, tiles, pipes, and pottery or earthenware, and in the mode of charging the ovens or placing or setting the articles that are to be fired therein.
121. A. Storry, Gorwydd Colliery, Swansea—Safety lamps.
122. W. Weild, Manchester—Machinery for winding yarn or thread on to bobbins, spools, cards, or other similar surfaces.
123. T. W. Mellor, Ashton-under-Lyne—Apparatus for measuring water and other fluids.

Dated 23rd January, 1858.

124. N. A. Drouet, and P. P. Le Coq, Paris—Treating chloride of sodium for obtaining therefrom certain useful products.
125. C. F. Vasserot, 45, Essex-street, Strand—A single and double acting machine, with electro-magnetic motive power.
126. J. Samwells, Dunstable, Bedfordshire, and C. H. Jones and C. Pickard, Leeds—Blocking and shaping hats, bonnets, and other coverings for tho head.
127. J. Gordon, 3, Railway-place, Fenchurch-street—Apparatus for pulping coffee.
128. J. Johnston, Paisley—Bonnets, caps, and other coverings for the head.
129. C. Burn, Blomfield-crescent, Westbourne-terrace, Paddington—Improvements in the manufacture of iron cables and chains, which improvements are applicable to the manufacture of gold and other chains.
130. J. Craven, Bradford, and W. Hey and C. Worsnop, Manningham, near Bradford—Actuating rotary shuttle boxes of looms.
131. E. Slack, Glasgow—Treatment or preservation of potatoes and other amylaceous vegetable substances.
132. J. J. Welch and J. S. Margetson, Cheapside—Folding travelling bag or wallet.
133. J. J. Huber, 14, Boulevart Montmartre, Paris—Construction of brooches, bracelets, pins, and other articles of jewellery.

Dated 25th January, 1858.

134. A. Wall, East India-road, Poplar—Lubricator for the moving parts of machinery.
135. G. E. Dering, Lockleys, Hertfordshire—Permanent way of railways.

Dated 26th January, 1858.

136. J. Garnett, Otley, and P. Garnett, jun., Cleckheaton, Yorkshire—Felt.
137. P. Hill, Hampstead, Middlesex—Machinery for making cams and for cutting and shaping metals.
138. Sir H. Stracey, Bart., Blackheath-hall, Norfolk—Cartridge.
139. G. P. Simcox, Hendham Vale Works, Harpurhey, Manchester—Carpets.
140. W. E. Newton, 66, Chancery-lane—A new fabric intended principally as a substitute for leather.
141. W. E. Newton, 66, Chancery-lane—Machinery for mining coal.
142. L. F. Corbelli, Florence, Tuscany—A new process for obtaining aluminium.
143. W. D. Hirst, Mount-street, Grosvenor-square—A stand for soda-water bottles.
144. J. Harthan and E. Harthan, Timbersbrook, near Congleton—Engine for obtaining motive power.
145. R. Heaton, jun., and G. Heaton, Birmingham—Annealing metals.

Dated 27th January, 1858.

146. T. Mottram, J. Edwards, and J. Mitchell, Yorkshire—Rolling steel, iron, and other metals, and also for tilting the same for cutlery and other purposes.
147. A. Bird, Birmingham—Spring platform or mattress for bedsteads.
148. G. J. Wainwright, Dukinfield—Drawing fibrous materials.
149. J. W. Midgley, Keighley, Yorkshire—Covered roller to be used in preparing and spinning machinery.

Dated 28th January, 1858.

150. J. M. Napier, Vine-street, York-road, and W. Thorburn, 19, Sussex-place, Vine-street, York-road—Machinery for planing, shaping, and slotting.
151. C. N. Kottula, Liverpool—Neutral soap.
153. L. Caemmerer, Ghent, Belgium—Apparatus for cleaning the top rollers and fluted rollers of the different spinning machines.
154. W. Spence, 50, Chancery-lane—Pots for chimneys and ventilation.
155. E. Lionvil, Paris—Apparatus for aërated liquids.
156. J. H. Johnson, 47, Lincoln's-inn-fields—Metal pipes.
157. T. Armitage, Hood-street, Coventry—Elastic fabrics.

Dated 29th January, 1858.

158. W. T. Fox, Birkenhead—Bending and reefing of ships and other vessels' sails, together with a new application for the leeches and foot.
159. J. Bethell, 8, Parliament-street, Westminster—Manufacture of coke and fuel.
160. W. H. Tooth, 9, Summer-street, Southwark—Polishing plate glass, sheet glass, and other substances.
162. J. Elder, Glasgow—Construction of steam engines and boilers.
163. G. Chapman, Leicester—Socks and drawers.
164. R. A. Brooman, 166, Fleet-street—Apparatus for measuring water and gas.
165. R. Ware, Plumstead, Kent—Galvanic batteries.
166. J. Wotherspoon, Glengarnock Iron Works, Ayr, N.B.—Railway brakes.
167. J. Goodwin, Milton, N.B.—Treatment, preparation, and cleansing of textile fabrics and materials.
168. H. W. Hart, Birmingham—Regulating the pressure of gas.

Dated 30th January, 1858.

169. W. Kaye and C. Kaye, Lockwood, near Huddersfield—Mattocks, picks, hoes, and hammers.
170. G. G. Nicol, 37, New Broad-street—Balls or projectiles.
171. C. Niellon, 50, Lime-street—Manure from sewage waters.
172. J. Newling, Park-street, Grosvenor-square—Truss for hernia.
173. R. Coleman, Chelmsford—Agricultural implements.
174. J. A. Bouck, Manchester—Manufacture of sulphate of copper, and in obtaining useful products.
175. T. Taylor, sen., T. Taylor, jun., and H. Nelson, Manchester, and H. Spencer, Rochdale—Steam engines, and apparatus connected therewith.
176. P. Ashcroft, Engineer to the South Eastern Railway—Supporting the rails of railways in their chairs.

Dated 1st February, 1858.

178. W. K. Hall 36, Cannon-street—Artificial leather.
180. G. Bartholomew, Linlithgow, N.B.—Horse shoes.
182. W. E. Newton, 66, Chancery-lane—Clasp or fastening for joining the ends of belts or bands.
184. R. A. Brooman, 166, Fleet-street—Burners for generating and burning gas from hydro-carbon fluids.
186. W. J. Hay, Southsea—Composition suitable for covering the caulking of ships and other like purposes, for uniting wood and other substances, for filling up seams, and for use as a waterproof composition generally.

Dated 2nd February, 1858.

188. W. E. Newton, 66, Chancery-lane—Obtaining certain compounds of nitrogen to be applied in the composition of artificial manures, and for other useful purposes.
190. J. Sholl, Victoria-grove west, Stoke Newington—Manufacture of paper for writing and copying purposes.

INVENTIONS WITH COMPLETE SPECIFICATION FILED.

70. M. A. F. Mennons, 4, South-street, Finsbury—Improvements in gas retorts.—16th January, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4044. Jan. 16. E. Page, Birmingham, "Improved Link or Fastener for Shirts, Gloves, and other articles of Wearing Apparel."
4045. „ 21. W. Bartleet and Sons, Redditch, "The Princess Royal Envelope for Needles."
4046. „ 22. G. F. Morrell, 149, Fleet-street, "A Rule, Pencil, and Penholder Combined."
4047. „ 23. W. Tonks and Son, Birmingham, "A Casement Stay."
4048. „ 29. A. Todd, Ardwick, near Manchester, "Invalid Bed Table."
4049. Feb. 2. Murray and Heath, 43, Piccadilly, "Reflectors for Stereoscopes."
4050. „ 2. W. Cooper, Birmingham, "Improved Stud or Fastener."
4051. „ 4. Rudall, Rose, Carte and Co., 20, Charing-cross, "Improved Configuration of a Drum."
4052. „ 6. H. F. Lawes, Bristol, "The Paragon Shirt."
4053. „ 8. The Edinburgh Machine Sewing Company, Edinburgh, "Royal Princess Corset Fastener."
4054. „ 8. Thewlis and Griffith, Warrington, "Churn Driving Apparatus and Stand,"
4055. „ 8. J. P. Oates, Erdington, "An Improved Piston for Valved Musical Instruments."
4056. „ 12. J. Hoare, Old Fishbourne, Rosham, Sussex, "The Hand Seed Planting Machine."
4057. „ 13. R. Sorby and Sons, Sheffield, "The Improved Sheep Shears."
4058. „ 16. J. Armstrong, Irthington, "Life Preserver."
4059. „ 17. J. Chesterman, Sheffield, "Spring Hat Suspender."

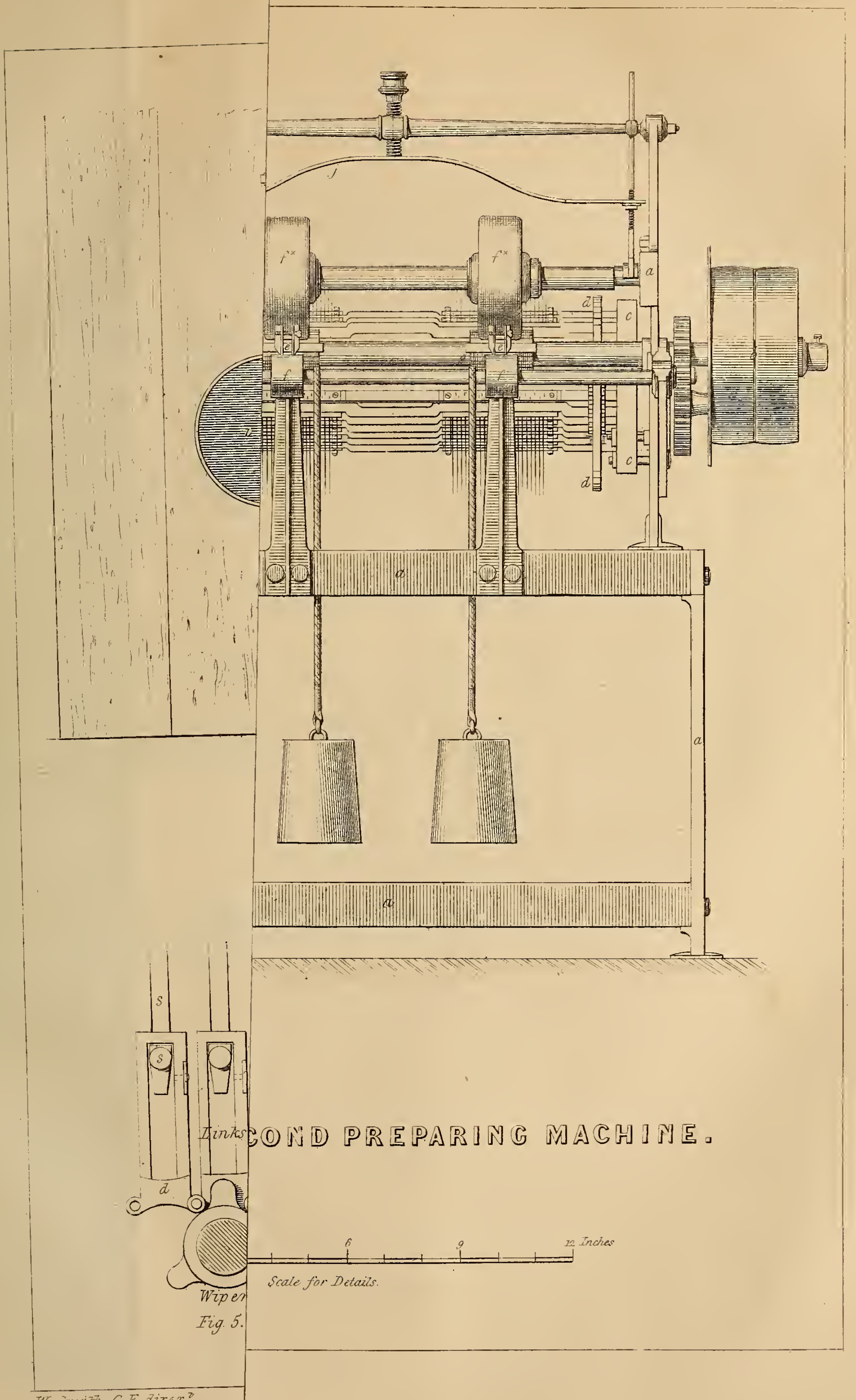


Fig. 5.

COND PREPARING MACHINE.

W. Smith, C.E. direx.

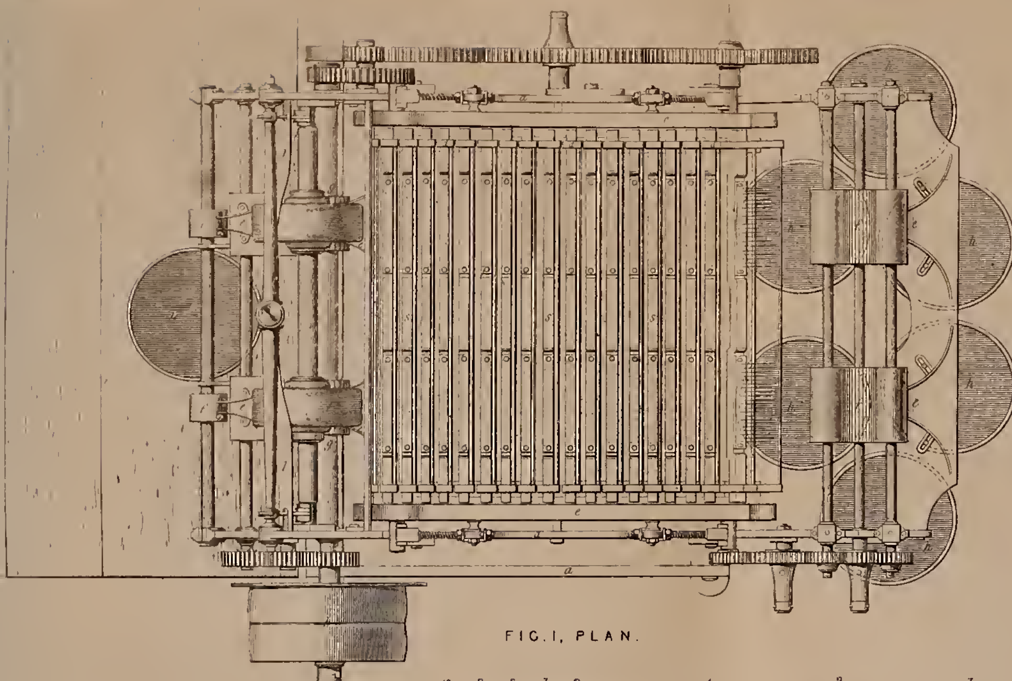


FIG. 1, PLAN.

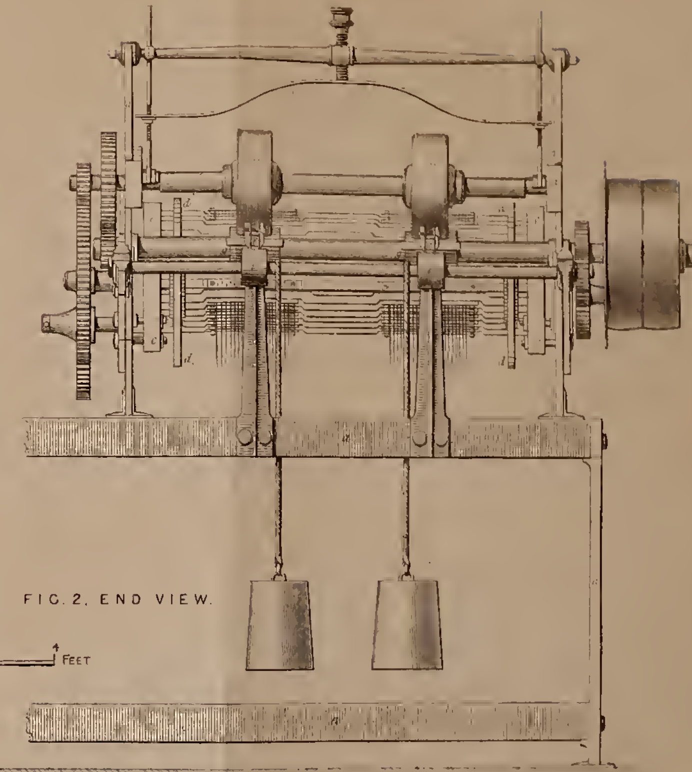
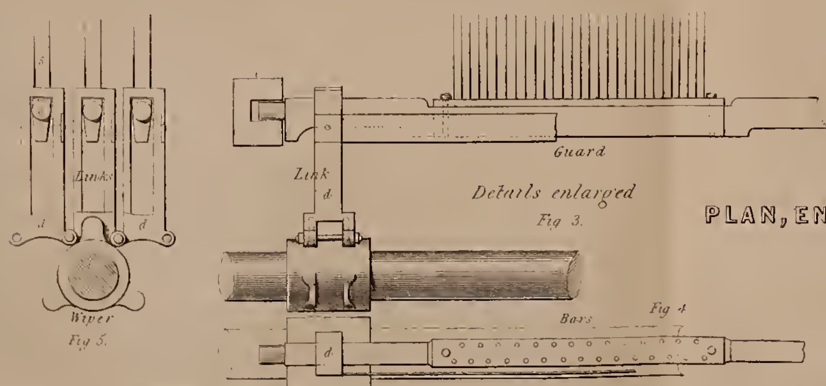
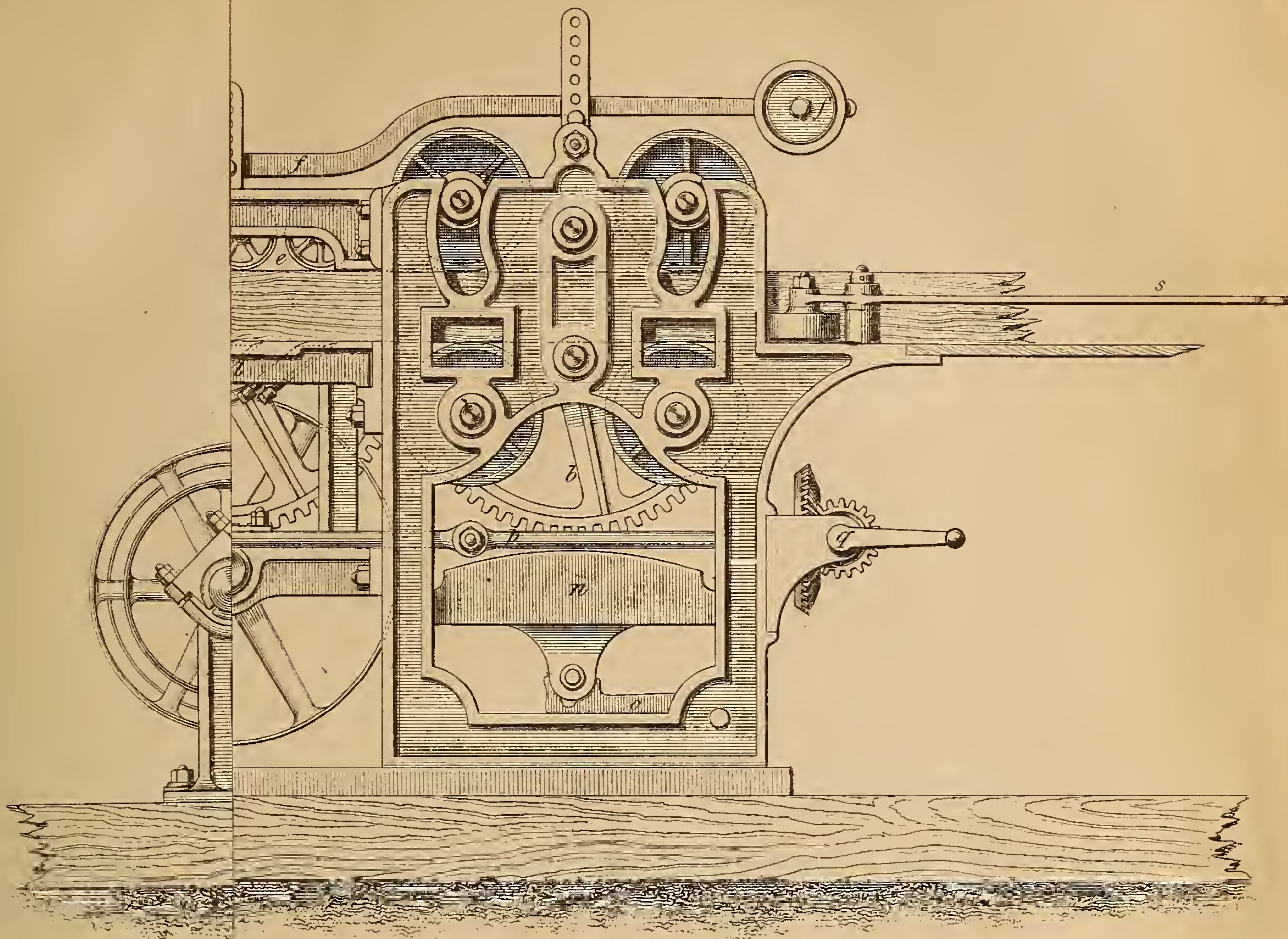
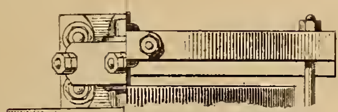


FIG. 2. END VIEW.



PLAN, END VIEW AND DETAILS OF SECOND PREPARING MACHINE.





WOOD PLANING MACHINE,

As Manufactured by

JAS HORN, ENGINEER, WHITECHAPEL,

LONDON.

FIG. 1, SIDE ELEVATION.

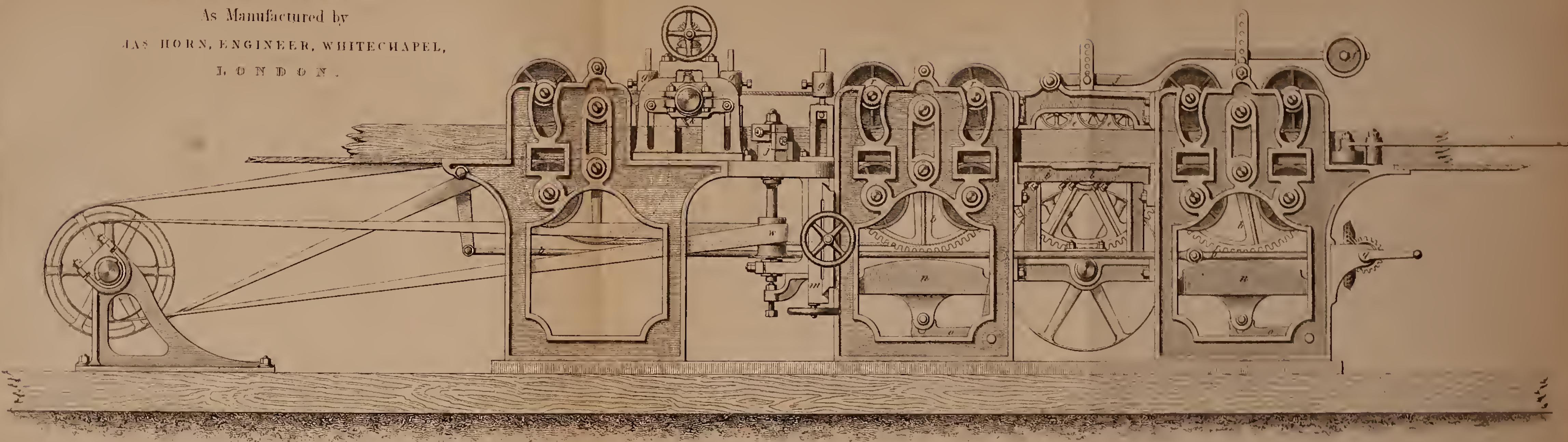
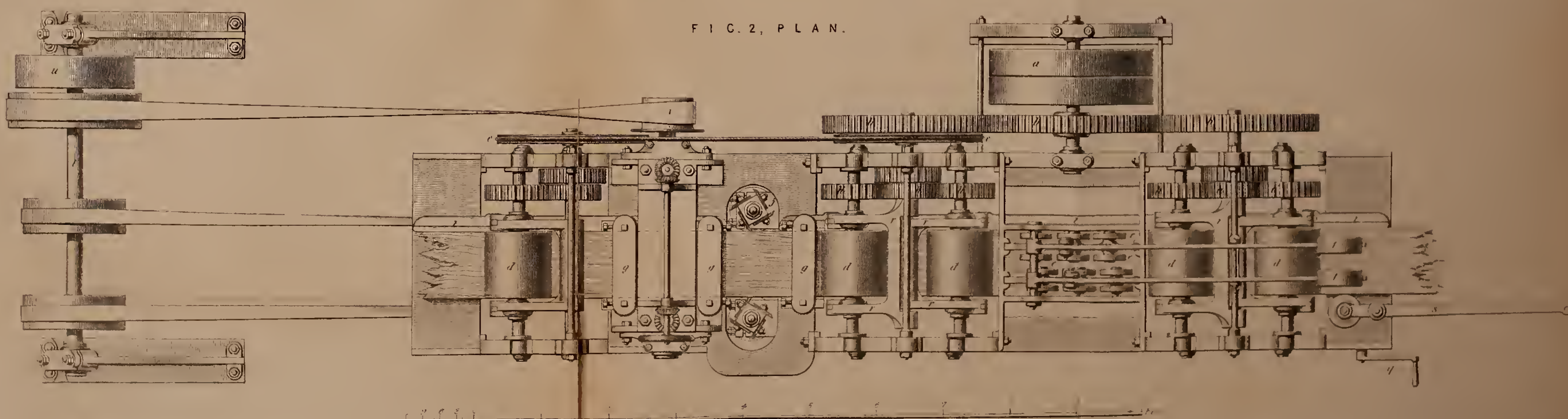


FIG. 2, PLAN.



THE ARTIZAN.

No. CLXXXIII.—Vol. XVI.—APRIL 1st, 1858.

HORN'S IMPROVED WOOD-PLANING MACHINE.

(Illustrated by Plate cxxi.)

We briefly noticed in our last Number Mr. Horn's excellent wood-planing machine, but were prevented from giving the copper-plate engraving thereof, and so deferred giving any further description of the machine until the present Number.

On reference to Plate cxxi., it will be perceived that this machine is differently constructed to those usually fed by rolls, inasmuch as in all the working gearing spur-wheels are applied; those driving the upper feed-rolls radiate upon the spindle by which they are driven, and, consequently, keep properly in gear, being a great improvement upon those driven by bevel wheels, which are frequently out of order.

The double set of binding rollers, *e*, *e*, with levers and weights, *f*, *f*, allow for the unevenness of the wood, being loosely fitted on their axis, and made to slide freely in the grooves made to receive the carriage; they are sure to bear upon the board, and prevent its passing the irons unplaned, although it may be unevenly cut.

The plane-iron box, in which the irons, *i*, *i*, are fixed, is made to slide in and out; and as the machine is supplied with two, when one set of irons become dull, it may instantly be removed, and a set of sharp ones (ready fixed) in the other box be substituted, without loss of time.

Any description of cutter for the side edges may be used, for grooving, tongueing, bevelling, or squaring up of the edges.

The operation of changing the feed-rolls from one thickness of board to another can be performed in much less time on this machine than on any other we have tried.

The sliding bearings of the large top adze have the strain taken off them by the four bolts and nuts, which slide in their respective slots, which, when raised to the height required, are made fast, rendering the adze spindle very firm, and equal to the severe work it has to do at times.

The following are the literal references to the several parts of the machine:—

a, the fast and loose pullies for driving feed rolls.
b, *b*, *b*, the three spur wheels for transmitting motion to feed rolls.
c, *c*, gut-pullies for driving back roller.
d, *d*, feed-rolls for propelling the wood.
e, *e*, binding rollers over plane irons.
f, *f*, levers and weights for binding rollers.
g, *g*, *g*, weights for binding rollers in front and back of adzes.
h, *h*, spur pinions, by means of which the feed-rolls are driven.
i, *i*, moveable plane-iron box, with irons dotted in.
j, *j*, side adzes for grooving, tongueing, &c., &c.
k, top adze for thicknessing the boards.
l, counter-shaft for driving top and side adzes.
m, transverse slides for giving different widths to side adzes.
n, *n*, weights for giving the necessary pressure to the top feed-rolls.
o, levers for raising the weights.
p, long rod for connecting all the top rolls with levers and weights.
q, handle for working the long rod, so as to raise the five top feed-rolls to the thickness of the wood required.
r, levers with bearings for top feed-rolls, each radiating upon the spindle which drives it by means of spur gear.
s, lever and pressing roller for entering boards.
t, *t*, fence or guide for boards while being planed.
u, driving-pulley for counter-shaft.
v, flange-pulley for top adze.
w, *w*, flange-pulley for driving side adzes.

HEMP AND FLAX SPINNING MACHINERY.

(Illustrated by Plate cxix.)

In The Artizan for February we gave a copper-plate engraving, exhibiting a side and end elevation of a second preparing machine; and at page 25, of the same Number, we gave a description of the machine. We now present our readers with a copper-plate engraving, exhibiting at Fig. 1, a plan; Fig. 2, an end view; and Figs. 3, 4, and 5, enlarged details of parts of the machine. *a* is the frame work; *b*, the driving pulleys or riggers by which motion is communicated to the machine; *c*, the guide frames, by which the ends of the heckle bars slide, as shown at *e*, Fig. 3; *d d*, the heckle links, also shown in detail, Fig. 5.

IRON WAREHOUSE ROOF, &c., AT ROUEN.

The accompanying illustrations are details of a warehouse erected by Mr. E. Burel, C.E., upon the Quay, at Rouen. The building has been very much admired, and is a very good example of a scientific combination of materials for the particular purpose; and the trellis girders are examples of the combined flat and T-iron bars, recommended by Mr. William Fairbairn, in his "Treatise on Wrought-Iron Beams," the flat bars taking the tension, and the T bars the thrust.

The roof is supported on eight octagonal hollow cast-iron columns, resting upon stone blocks, which are bored for admitting the passage of water, which, falling on the roof, is allowed to flow down the columns, which act as rain-water pipes, the water being collected by a suitable drain, which runs round the bases of the columns.

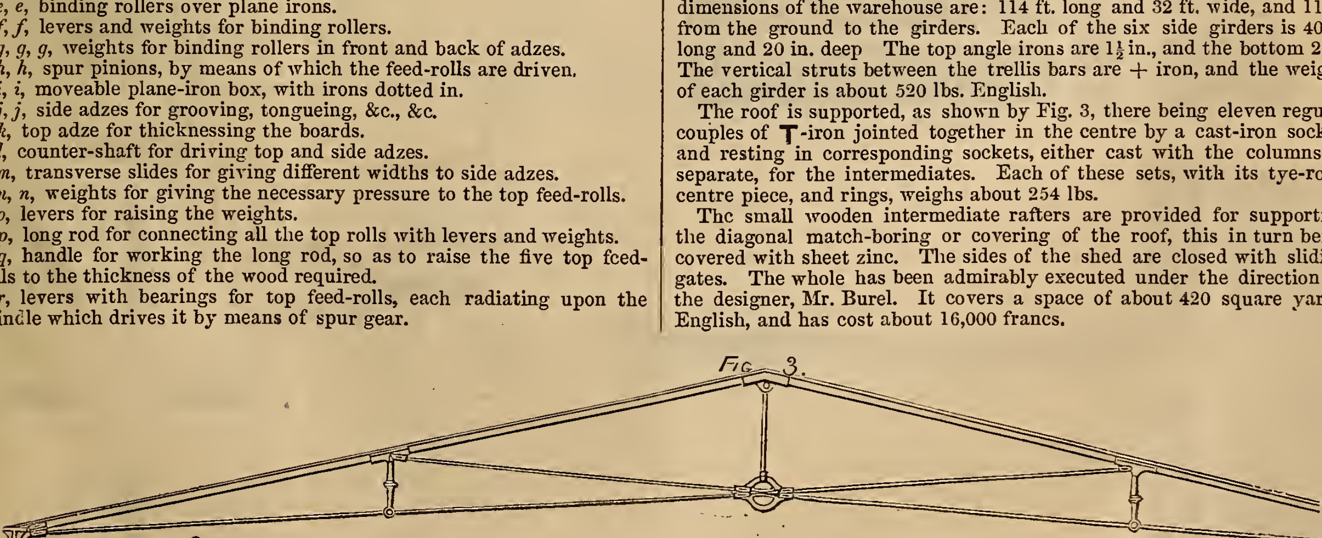
The construction of the roof needs no description, as, on reference to the illustrations, it will be readily understood.

The combination of flat and T-iron bars in the trellis girders running round the building, presents on one side only the appearance of T and flat iron; whilst, on the outside, it presents the appearance of two flat bars crossing each other longitudinally in each compartment. The dimensions of the warehouse are: 114 ft. long and 32 ft. wide, and 11 ft. from the ground to the girders. Each of the six side girders is 40 ft. long and 20 in. deep The top angle irons are $1\frac{1}{2}$ in., and the bottom 2 in. The vertical struts between the trellis bars are + iron, and the weight of each girder is about 520 lbs. English.

The roof is supported, as shown by Fig. 3, there being eleven regular couples of T-iron jointed together in the centre by a cast-iron socket, and resting in corresponding sockets, either cast with the columns or separate, for the intermediates. Each of these sets, with its tye-rods, centre piece, and rings, weighs about 254 lbs.

The small wooden intermediate rafters are provided for supporting the diagonal match-boring or covering of the roof, this in turn being covered with sheet zinc. The sides of the shed are closed with sliding gates. The whole has been admirably executed under the direction of the designer, Mr. Burel. It covers a space of about 420 square yards English, and has cost about 16,000 francs.

Fig. 3.



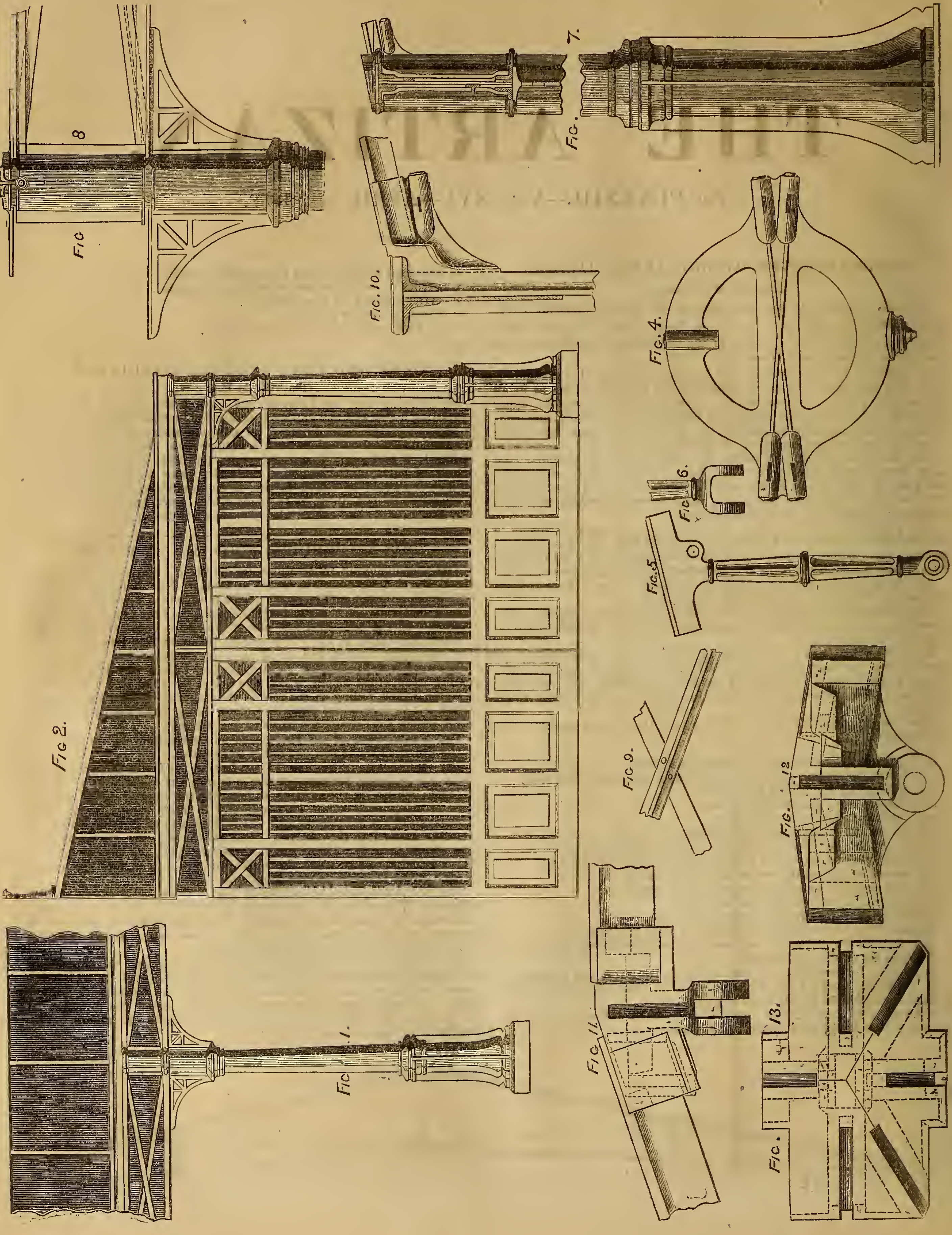
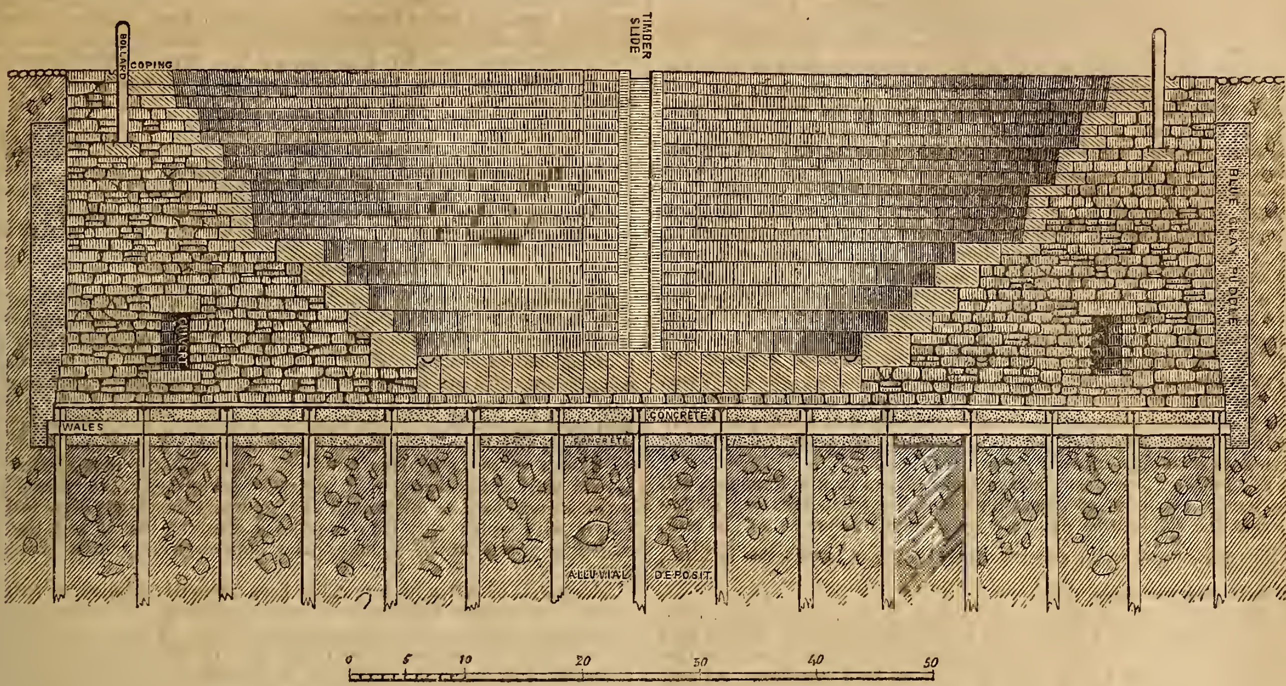


Fig. 8
Fig. 7.
Fig. 10.
Fig. 4.
Fig. 6.
Fig. 5
Fig 2.
Fig 9.
Fig. 12
Fig. 1.
Fig. 11.
Fig. 13.

DUBLIN GRAVING DOCK.



In pursuance of the promise made in last month's Number, we present to our readers the first of our illustrations of the Dublin Graving Dock —a cross section through the dock between the timber slides. The piles, as shown in the section, are placed 7 ft. 3 in. from centre to centre, excepting the centre piles, which are 6 ft.; the shoeing of these piles was effected in the most careful manner, and the piles themselves are of crown memel, adopted after a cautious selection by experienced persons.

Over the longitudinal bearers, the platform, consisting of 4-in. planking, was laid, spiked down to the bearers, and on this was built the masonry, which consisted first of a 12-in. course of black stone or calp, procured principally in the quarries at Donnybrook; on this course was set the floor of Killiney granite, 3 ft. 6 in. in thickness or depth in the middle, and falling off at either side to 3 ft. Along each side is a drain, 12 in. in width by 6 in. in depth. The floor consists of nineteen courses of granite, the three central courses being level, the others falling with a slight inclination to either side.

From this floor rise the steps and altars, each 2 ft. high by 2 ft. wide; five of these bring us up to the broad altar, which is 6 ft. wide, and from which the next series of steps, four in number, rise with a face batter of one in twelve; the step next to the altar is 5 ft., and the other three, 3 ft. in height.

The width of the dock at the floor-level is 37 ft. 8 in., and at the coping, 80 ft. in the clear. By the very judicious arrangement of the steps and altars, a large amount of light will be enjoyed by shipwrights in this dock, which has also a great advantage in being built of granite of a beautiful light colour. The backing, and all the under work, is of calpe.

The culverts, shown in the section, are for the purpose of emptying the dock; they are very carefully constructed, and completely surround it, meeting in a point at the head where they will communicate with the well of the pumping engine, which is not yet built.

At invervals, as will be seen, are placed cast-iron posts or bollards, which will be found of the greatest service in mooring vessels and adjusting them in their position on the blocks. There are also slides formed along the sides and head for the purpose of the more easily letting down the bent timbers, &c., for vessels.

The total depth in the centre is 23 ft. 6 in., and the centre of the floor is 5 ft. lower than the low water of spring tides in Dublin Harbour; the average rise of which is about 13 ft.

AN INQUIRY INTO THE STRENGTH OF BEAMS AND GIRDERS OF ALL DESCRIPTIONS, FROM THE MOST SIMPLE AND ELEMENTARY FORMS, UP TO THE COMPLEX ARRANGEMENTS WHICH OBTAIN IN GIRDER BRIDGES OF WROUGHT AND CAST IRON.

By SAMUEL HUGHES, C.E., F.G.S., &c.

(Continued from page 31.)

[ERRATUM AT PAGE 29.—The hydraulic proving machine, and the lever apparatus, of which engravings are given at page 29, have been marked erroneously as Fig. 27 and Fig. 28. Mr. Fairbairn's lever machine should be Fig. 27, and the hydraulic proving machine should be Fig. 28.]

MITCHESON'S HYDRAULIC PROVING MACHINE.

In this apparatus, which was described at page 30, there is a further contrivance for reading off small pressures, which has not been alluded to. I have already explained that 1 lb. weight placed in the scale at d would indicate a pressure on the piston $A = 3{,}041$ lbs. Hence, an ounce in the scale would indicate 190 lbs. pressure; and as it would be troublesome to employ weights so small as an ounce, with its subdivisions, the determination of small pressures is provided for in another manner. Thus the lever, $b\,f$, is divided into 320 equal parts, each of which indicates one quarter of a cwt., and by means of a small moveable weight, which can be moved from b to f, any pressure up to 4 tons can be read off on the lever without using the scale, d, at all. By means of this division of the lever, a pressure of 28 lbs. can be readily distinguished, as the divisions which indicate quarter cwts. are one-third of an inch apart. It will be observed that this mode of ascertaining small pressures is much more convenient than using weights in the scale, because the weight to indicate 28 lbs. would be extremely small—not much more than the eighth part of an ounce.

Tests of Tensile Strength.

It has been usual to test the links and vertical rods of suspension bridges with 9 or 10 tons per square inch of section. Several of the earlier authorities, however, have asserted that iron of good quality will bear a much higher tensile strain than this without stretching. Mr. Telford found in his experiments on bars which withstood a breaking weight of 29 tons per inch, that the iron began to stretch in the best specimens with $\frac{75}{100}$ of the breaking weight; and in the worst specimens with $\frac{45}{100}$, or 12·74 tons per square inch. Mr. Donkin once stated in evidence before the House of Commons, that he had witnessed experiments in which iron bars 1 in. square did not begin to stretch till loaded with 16 tons. This was probably 60 per cent. of their ultimate strength.

In these earlier experiments, it is most likely incorrect to say there was *no* extension with the weights which were applied, because such an assertion would be directly contradicted by Mr. Hodgkinson's more recent and much more accurate investigations. All that was meant is probably this—that, up to the weights named, the elasticity of the bar was not injured: that is, there was no permanent set, and that the bar on being released from the weight returned to its original length. Thus we find in Mr. Hodgkinson's experiments that, although wrought iron began to stretch with considerably less than 10 tons, yet that up to this weight the elasticity was not at all injured. Drewry asserts in his book, already quoted, that wrought iron will bear a weight of 9 tons per square inch without stretching at all; that is, without permanently stretching, or having its elasticity injured.

Mr. Edwin Clark observes, that a circular rod, an inch in diameter, will bear a tensile strain of 16 tons, which is equal to 20 tons per square inch: that the rod will be damaged by a weight equal to 8 d^2 in tons, or 10 tons per square inch; and that the usual load in practice is $\frac{16\ d^2}{3}$, or nearly 7 tons per square inch.

Mr. Page states, in his Report on Chelsea Bridge, dated April, 1856, that he has fixed a proof test of 13½ tons per square inch for the bars of the chains, and that more than 1,100 bars have been proved to this test, with a permanent extension of $\frac{1}{400}$ of an inch per foot. As this extension is equal to $\frac{1}{4800}$ of the whole length, and is produced by 13½ tons, it follows that the iron must be of very superior quality. We have seen that for ordinary bar iron the extension has been $\frac{1}{12500}$ per ton; so that the extension for 13½ tons at this rate would be more than $\frac{1}{1000}$, whereas the proof extension is only $\frac{1}{4800}$ of the whole length. Mr. Page observes that, in experiments which he has made on the tension of iron, "he found, that by comparing the stretch and permanent set on ordinary iron and the best iron, prepared for the purpose of experiment, there was no perceptible difference up to 11 tons on the square inch of section; even up to 12 tons the difference was very slight; but at 13 tons the permanent set in the common iron was very decided; and at 23 tons on the inch, when the ordinary iron broke, having stretched 6 in. in 4 ft., the best iron had not stretched permanently one-twelfth of an inch in 4 ft. The permanent set of this iron with 29 tons was one-fiftieth of an inch; and it broke with 31 tons."

All the iron used in the Menai Bridge was proved with a tensile strain of 11 tons per square inch.—*Drewry.*

The bars used in the Hammersmith Suspension Bridge were proved for tensile strength up to a weight of 9 tons per square inch.—*Ibid*

Mr. William Clay, of the Mersey Steel and Iron Works, has lately published some experiments to show that bar iron increases in strength with each successive piling, heating, and rolling, up to a certain number of times, after which it diminishes at about an equal rate.

Thus, he found that an ordinary puddled bar of fibrous iron broke with a tensile strain of 19·6 tons per square inch, and that iron from this bar gradually increased in strength after each re-piling, until it had been worked five times over, when it had attained a tensile strength sufficient to bear a weight of 27·6 tons, or nearly 50 per cent. more than the strength of the simply puddled bar. The iron was again and again piled, heated, and rolled, the strength being tested as before at each operation, when it was found to decrease each time, till it had undergone in all twelve workings, when the strength was just the same as that of the original puddled bar. Mr. Clay states that a somewhat similar effect takes place in puddled steel bars, which before piling had a tensile strength of 43·2 tons. After the first piling, when the bar had become solid, the strength was more than 54 tons, from which it gradually diminished, till, after being worked five times, the strength was somewhat less than that of the puddled bar; after which four additional pilings and rollings produced neither increase nor diminution of strength.

As the strength of steel is from two and a half to three times that of wrought iron, the possibility has been entertained of introducing it into some of the parts of iron bridges, particularly for those on the principle of suspension. The great desideratum is, of course, to obtain the article at a price which would enable it to compete commercially with wrought iron. The following are ascertained strengths for various descriptions of steel, as quoted by Mr. Clay in his recent Paper read before the Society of Arts.—See The Artizan, page 36.

The War Department at Berlin found the strength of Krupp's cast steel, from three experiments, equal to 49·9 tons per square inch. Mr. Mallet found the highest tensile strength of tilted cast-steel bars equal to 63·49 tons, the mean strength being 39·58 tons. Other authorities give the strength of shear steel and blistered steel from 55·5 to 67 tons per square inch; and Mr. Clay himself has particularly experimented on wrought-steel bars, the tensile strength of which he found as follows:—

	Tensile strength in tons per square inch.
Mersey Steel and Iron Company's puddled steel, highest...	77·59
Do. do. another sample............	71·80
Average of three samples tested at the Liverpool Corporation Testing Machine	50·00

On Trussed Cast-Iron Girders.

The compound form of beam known as the cast-iron girder, trussed with rods or bars of wrought iron, owes its origin to the remarkably distinctive manner in which cast and wrought iron severally resist compression and extension. When it became known that cast iron resisted compression with six times the force which it opposed to extension, and that, on the other hand, it required much more force to extend wrought iron than to compress it, the value of a beam in which these opposite properties should be brought into profitable action could not fail to present itself to the ingenious minds of those who for many years have turned their attention to this subject. Accordingly, the trussed beam was designed to take advantage at the same time of the high resisting power with which cast iron opposes a crushing force, and the high resisting power which wrought iron opposes to a tensile or tearing force.

Truss rods of wrought iron have been variously applied to cast-iron beams. Sometimes their extremities are attached below the top flange of the beam, and sometimes considerably above. The truss rod is either in one piece or several. The lower part of the truss-rod sometimes passes entirely under the beam, and is occasionally just above the bottom flange. The truss rods can be screwed up or unscrewed at their points of attachment at each extremity of the beam, so as to give them any required degree of tension, and to adjust them for variations of temperature, &c.

Mr. Fairbairn is of opinion that considerable economy of material would be effected if a truss beam could be so constructed that the two kinds of iron should act in concert—namely, that the cast iron should be on the point of crushing just when the wrought-iron rods are on the point of extension. He states, however, that this is impracticable; and observes, that if too great a tension be given to the rods they will break before the beam has arrived at the condition of rupture; while, on the contrary, if too small a tension be given to the rods, the beam will break before they have arrived at their condition of rupture.

It is probable that public attention was first called to the defects of trussed beams by the failure of the bridge over the Dee, on the Chester and Holyhead Railway. Mr. James Walker and Captain Simmons, in reporting on this accident, observe, after describing the construction of the bridge, that "it is evident, if the wrought-iron tension rods act at all, they become stretched out and lengthened, while the cast-iron girder does not lengthen to the same extent. This is the natural tendency, from the different ways in which the weight acts upon them, the one being by a strain or pull in the direction of the length, the other by a transverse pressure, which tends to lengthen the lower flange, and to compress the upper one, the neutral axis lying between them." In this bridge, as will hereafter be seen, the tension bars were suspended from a point which was twice the depth of the girder above the bottom flange, and, therefore, the reporters observe, that the strain upon the girders, aided by the leverage thus given to the tension bars, had the effect of drawing closer the points of suspension, and thus loosening the tension bars; they found, in fact, that a load of 48 tons on the bridge caused the point of suspension on one side to move 7-16ths of an inch, and if the other point did the same, the distance between them would be lessened to the extent of 7-8ths of an inch, and the tension bars loosened in proportion.

"Although at first the cast and wrought iron may act together, which is the strongest condition of the bridge, more of the pressure becomes by degrees transferred to the cast iron, causing a deflection. The vertical trussing bolts which pass through the girder may then be screwed up, the effect of which will be to raise the girder in the middle. This trussing process was adopted at the first adjustment of the bridge, before the piles or props were removed—the weight of the girders alone having caused a deflection from the straight line; they were then raised by wedges, and otherwise, until they were 1 in. or 2 in. above the straight line, or cambered from 1 in. to 2 in.; and while in this condition the truss or tension rods were applied. If, after this, a deflection took place, the screwing might be applied and continued until the lower flange of the girder was brought up so as to come into contact with the bolts or

with the links, which was the case with most of them at the time of our survey; but after the girder was thus raised, so that the bolt came into contact with either the bottom flange or with the bottom of the hole through the girder, there was no means of further adjustment to counteract the natural operation above described."—*Report to the Board of Trade, by Mr. Walker and Captain Simmons.*

The objections taken by Messrs. Walker and Simmons to beams trussed with wrought iron on account of the unequal extension produced by the same weights acting on each, have been much enlarged on by Mr. Fairbairn, who enters into a very ingenious examination of the effect produced on trussed beams under various circumstances. He first examines the case in which the truss rods have no initial strain or tension upon them when the beam is unloaded. He shows, on the supposition that the whole length of the truss rod is equal to the length of the beam (which, owing to the great obliquity of the truss rods is sufficiently near for the purpose of calculation), that when the beam is loaded with a weight sufficient to produce a tensile strain on the cast iron of $2\frac{1}{2}$ tons per inch, the wrought iron will at the same time be subject to a tensile strain of $5\frac{1}{2}$ tons per square inch. Here it is assumed that both the cast iron and the wrought iron are equally extended; and it had previously been found by experiments on 10-ft. bars that 5·6 tons per square inch was required to produce in wrought iron the same extension that was produced in cast iron by $2\frac{1}{2}$ tons. Taking the breaking weight of cast iron by tensile strain at $7\frac{1}{2}$ tons, and that of wrought iron at 24 tons per square inch, he observes, that in the case supposed, the cast iron is strained to one-third of its breaking weight, while the wrought iron is only strained to one-fifth of its ultimate strength.

It appears from experiments on the permanent sets produced on the two kinds of iron, after the equal extension here supposed, that the cast iron would be permanently elongated about six times as much as the wrought iron. This will have the effect of giving a certain degree of tension to the truss rods, and this Mr. Fairbairn observes will not act unfavourably.

Mr. Fairbairn next examines a case in which the beam is so loaded as to produce upon the cast iron a tensile strain of $5\frac{1}{2}$ tons per square inch; and here again, as he assumes that two and a quarter times this weight are necessary to produce a similar extension of the wrought iron, he again finds, assuming the same high tensile strength for the wrought iron, the same disproportion between the strain on the cast iron and that acting on the wrought iron.

The truth is, that within the limits of strain, which can be safely applied to cast-iron beams of any description, Mr. Fairbairn's objection to trussed girders is based on this fact, that the tensile strength of wrought iron bears a higher proportion to that of cast iron than the weights required to produce an equal extension in both cases.

Thus he shows by experiments, that within the limits of 6 tons* tensile strain per square inch for cast iron, corresponding with $13\frac{1}{2}$ tons* for wrought iron, the tensile force applied to wrought iron must be two and a quarter times the tensile force applied to cast iron, in order to produce equal elongations. Now, if the relative strength of cast and wrought iron to resist a tensile force were also in the ratio of 1 : $2\frac{1}{4}$, then each kind of iron would be equally strained by any weight which could be safely applied to a trussed girder. But as Mr. Fairbairn takes the relative tensile strength of cast and wrought iron to be in the ratio of $7\frac{1}{2}$ to 24, or as 1 : 3·2, it follows that they are unequally strained, in all ordinary cases, where no initial tension is applied to the truss rods. With respect to the comparative set of the wrought iron and the cast iron, it seems that within the limits of safe load, the former is much less than the latter; whence it may be concluded, that a heavy load applied to a trussed beam, if sufficient to produce a permanent set in the cast iron, would have the effect of tightening or producing a tension on the wrought iron, which, as before explained, Mr. Fairbairn considers rather an advantage than otherwise.

When the beam is so loaded as to produce on the truss rods a tensile strain of 15 tons per square inch, Mr. Fairbairn shows that the cast iron would be ruptured before this strain could come on the truss rods. He arrives at this conclusion from the fact that a strain of 15 tons on the truss rods produces an elongation in the cast iron equal to $\frac{1}{440}$ part of its length. But the ultimate elongation of cast iron at the point of rupture is only $\frac{1}{550}$ of its length, so that the cast iron will break before the strain of 15 tons per square inch can come on the truss rods. It must be observed, with reference to this conclusion, that practically it is not important, as 15 tons is far in excess of the safe strain per square inch of the truss rods. In fact, the limit of $2\frac{1}{2}$ tons per square inch for the cast iron, or 7 tons for the wrought iron, is seldom exceeded in practice; and we have seen the conditions under which Mr. Fairbairn's objections to the trussed beam are capable of being sustained within these limits.

Mr. Fairbairn next examines the case in which a high degree of initial tension is given to the truss rods, and shows that when this tension amounts to 8 tons per square inch, the truss rod will have an elongation of ·0077 in. per foot of its length. Now, suppose the cast iron about to fracture with a tensile strain of $7\frac{1}{2}$ tons upon it, this will extend both cast and wrought iron ·022 in. per foot, and this elongation being added to the initial elongation of ·0077, is equal to ·02976 in. per foot, which only corresponds to a strain of 16 tons per square inch on the wrought iron. Hence, Mr. Fairbairn concludes that no higher strain than 16 tons per square inch can be produced on the wrought iron at the moment when the cast iron is about to rupture.

From reasoning of this kind, Mr. Fairbairn determines that it is impossible to have the two metals acting in concert at tensions approaching their rupture.

Having thus shown that no advantage is gained by the wrought-iron trusses, either when the tension rods are without an initial strain, nor when this initial strain is very high, Mr. Fairbairn lastly examines the intermediate case in which a moderate or slight initial tension is applied to the truss rods. Here he proposes to discover the tension which must be given to the truss rods, so that the different parts of the truss beam may each be loaded at the same moment, with one-third of their respective ultimate tensile resistances—namely, $2\frac{1}{2}$ tons per square inch for the cast iron, and 8 tons per square inch for the wrought iron.

Now, when the cast iron has a strain of $2\frac{1}{2}$ tons, the wrought iron will require a strain two and a quarter times as great, or $2\frac{1}{4} \times 2\frac{1}{2} = 5\frac{5}{8}$ tons per square inch; hence, the initial strain should be $8 - 5\frac{5}{8} = 2\frac{3}{8}$, or say $2\frac{1}{2}$ tons per square inch. Now, suppose this beam to be loaded so as to produce a tensile strain of 4 tons per square inch on the cast metal, then the truss rods, in order to be elongated to the same length, will undergo a strain of $4 \times 2\frac{1}{4} = 9$ tons; this added to the initial strain of $2\frac{1}{2}$ is equal to $11\frac{1}{2}$ tons per square inch, at the moment when the cast iron is strained with a force of 4 tons. Mr. Fairbairn shows by experiment, that when the beam is so loaded, the sets of the two metals are nearly identical; and he considers that each metal would, with this load, be strained to about half its breaking weight.

Now, although Mr. Fairbairn thus determines that the most eligible adjustment is attained by giving an initial tension of about $2\frac{1}{2}$ tons per square inch to the truss rods, yet he observes that a load of $5\frac{1}{2}$ tons per square inch on the cast metal would tend to destroy this adjustment, because this will produce a strain of about $13\frac{1}{2}$ tons per square inch on the wrought iron, and after the load is taken off the set of the truss rods would be three times that of the cast iron

The following is Mr. Fairbairn's rule for computing the strength of these compound or trussed beams:—Add three times the section of the truss rod to the section of the bottom flange; substitute this sum for the bottom area in the usual formula for calculating the strength of cast-iron beams, and the result will be the breaking weight, or one-third will be the weight of safety. The usual formula which Mr. Fairbairn here speaks of is, $W = \frac{2{\cdot}16\, a\, d}{l}$; and putting a_1 for the area of the truss rods, the formula for a trussed beam will be, $W = \frac{2{\cdot}16\,(a + 3\,a_1)\,d}{l}$; the increase of strength produced by the trussing being $\frac{6{\cdot}5\,a_1\,d}{l}$. From a comparison of this with the ordinary formula, it appears that when the area of the truss rods is equal to one-third the area of the bottom flange, the strength of the beam is doubled.

Mr. Fairbairn considers the defects of the truss beam are increased when the tension bars are suspended from points lying above the top flange of the beam; and in this he appears also to be supported by the opinions of Mr. Walker and Captain Simmons, as they remark on the increased leverage given by this high attachment in the case of the Dee Bridge.

Owing to the great difference of opinion as to the strength of trussed beams, and the extreme importance of the subject as affecting railway constructions, Mr. Fairbairn made some experiments on beams trussed and untrussed, which I now proceed to examine.

The first set of experiments was made on a beam of the Hodgkinson form, placed on supports $4\frac{1}{2}$ ft. apart, and having the following dimensions:—

			Sq. in.	
Top flange	1″ × ·20		·20	Extreme depth of beam 4 in.
Bottom ditto	2·5 × ·42		1·05	
Rib	3·4 × ·25		·85	
		Whole area	2·10	

This beam, without truss rods, and with the bottom flange placed below, broke with a weight of 5,830 lbs.

Now, the coefficient of this beam, reduced to unity of length in feet, and to unity of depth, and area of bottom flange in inches, is

* These limits are higher than the tensile strain to which it would be safe in practice to subject either cast or wrought iron, so that the law here laid down will hold good for all cases of actual practice.

$\frac{4\cdot5 \times 5\cdot830}{2240 \times 1\cdot05 \times 4} = 2\cdot79$; also the coefficient reduced to unity of length in feet, and to unity of depth, and whole area in inches, is $\frac{4\cdot5 \times 5\cdot830}{2240 \times 2\cdot10 \times 4} = 1\cdot39$.

Three experiments were then made on the same beam with two truss rods, each half an inch diameter, suspended from the top flange of the beam, and passing at the centre beneath the bottom flange. In the first experiment the beam broke from one of the truss rods yielding to tension with only 5502 lbs., or a less weight than the beam had borne without truss rods at all. In the second and third experiments the beam broke respectively with 7944 lbs. and 8854 lbs., = 3·546, and 3·953 tons.

Taking experiment 2, in order to determine what multiple of the truss rod area must be added to the bottom flange in order to give the real breaking weight, it will be found that *less than once* the whole area must be taken, instead of three times, as Mr. Fairbairn assumes. Thus the beam without truss rods at all breaks with 5830 lbs., or 2·603 tons; with truss rods, having a section of ·3927 in., the beam breaks in experiment 2 with 3·546 tons, or it bears ·943 tons more. Hence, putting c for the constant or multiple of the tension rod area, its value will evidently be found from the following equation, $\frac{2\cdot79\ d \times \cdot3927\ c}{l} = \cdot943$, reducing which, and substituting the proper value for d and l, we find $c = \cdot97$. In fact, if we substitute unity for c in the formula for the bottom flange, we shall find it give something more than the weight which actually broke the beam with the tension bars. Thus W = $\frac{2\cdot79\ (a + a_1)\ d}{l} = \frac{2\cdot79 \times 1\cdot4427 \times 4}{4\cdot5} = 3\cdot578$ tons; whereas, the weight which actually broke the beam was only 3·546 tons; so that once the area of the tension rod is too much. Next, if we treat experiment 3 in the same manner, we find that the beam here was 1·35 tons stronger than without the tension bars. Hence, $\frac{2\cdot79\ d \times \cdot3927\ c}{l} = 1\cdot35$, and, reducing this as before, we find $c = 1\cdot386$, or still very far from three times.

An experiment was next made on the same kind of beam with the broad flange uppermost, and two truss rods, each three quarters of an inch diameter. This beam broke with a weight of 12,316 lbs., or 5·498 tons. Now it is useless to compare this breaking weight with that which broke the inverted beam without truss rods, because this is a form in which the beam would never be used in practice. The only comparison worth making is with the breaking weight of 2·603 tons, where the beam was tried in its strongest position without truss rods.

The difference, or 5·498 — 2·603, being 2·895, and the area of the three-quarter inch truss rods being ·88, we find, as before, the value of c from the equation $\frac{2\cdot79\ d\ \cdot88\ c}{l} = 2\cdot895$. Hence, $c = 1\cdot327$, which is something less than its value in the last experiment; so that no advantage appears to be gained by reversing the beam, while very great danger would be incurred, supposing the load to come on the beam at a time when the tension rods are slack.

It seems from these experiments that, in computing the strength of a beam with tension rods, it would be very unsafe to add more than the simple area of the truss rods to that of the bottom flange in Mr. Fairbairn's formula.

We have seen that in the beam experimented on, the coefficient for the whole area of the cast-iron beam is 1·39, or exactly half of that for the bottom area; hence, when the beam has truss rods, double the area of these may be added to the area of the cast-iron beam in computing its strength by means of a coefficient applied to the whole area.

The proportions of material are such in ordinary railway girders that the coefficient applied to the whole area should seldom exceed unity. Hence, calling a_1 the area of the truss rods, the expression $\frac{d\,(\mathrm{A} + 2\ a_1)}{l}$ = breaking weight in tons for a trussed girder .... (41).

Mr. Fairbairn's formula for a length in feet and area of bottom flange is $\frac{2\cdot16\ (a + 3\ a_1)\ d}{l}$ = breaking weight; whereas it appears to me, from his own experiments above quoted, that this should be $\frac{2\cdot16\ (a + a_1)\ d}{l}$.

It will be observed that these conclusions, as to the small value of the tension bars, as actually derived from Mr. Fairbairn's experiments, are further dependant on the proper and simultaneous resistance of the wrought iron; whereas, it has been shown already, and will be made more apparent hereafter, that this simultaneous action is, in many cases, very doubtful and uncertain. On the whole, I perfectly agree with Mr. Fairbairn that there is not much gained in the strength of cast-iron beams by the addition of malleable iron truss rods, and that well-constructed wrought-iron beams are infinitely preferable.

Mr. Glynn seems to be of the same opinion as Mr. Fairbairn with respect to these compound girders. In a communication to the Commissioners of 1849, he objects to the use of wrought iron as an auxiliary to cast iron, because he thinks each of the two metals cannot be made to take its own share of the burden, but that either one or the other must first bear it.

The built cast-iron girder, composed of several pieces, and strengthened with wrought-iron tension rods, has been employed extensively by Mr. Robert Stephenson and Mr. Bidder: for instance, in the bridge over the Minories, for the Blackwall Railway, and in the bridge over the River Lea, near the Rye House, on the Cambridge line of the Eastern Counties Railway. They were also used in many bridges on the Midland Railway.

The following are some of the principal examples of trussed girder bridges which were extensively adopted for railways previous to 1847, when the failure took place in a bridge of this kind on the Chester and Holyhead Railway. Since this time the cast-iron trussed girders have been abandoned.

Built Girder Bridge, or Viaduct, with Tension Rods, on the York and Scarborough Branch of the York and North Midland Railway.

This viaduct consists of two openings, each of 69 ft. span on the square, and 74 ft. on the skew. Each opening is covered by four lines of girders, which are not equidistant, the two centre ones being 5 ft. apart, while the two outer ones are each 9 ft. apart; the centre interval of 5 ft. is used as a public footpath across the River Ouse. Each line of girders over both the openings is composed of three separate pieces, bolted together, and these are strengthened by wrought-iron tension bars, one on each side, also in three lengths, connected at the two joints by a short round transverse bolt, passing through an opening at the meeting of the corresponding bottom joints of the girders, but without penetrating the iron of the latter. The centre part of each tension rod is horizontal, and lies almost on the bottom flange of the girder. The end bar of each tension rod is attached at the extremity to the top of the girder, and is inclined to the horizon at an angle of about 8°. The girder at the ends and at the two joints is 4 ft. 6 in. deep, and in the centre is 3 ft. deep.

The top flange is 8 in. by 2 in.; the middle rib is $2\frac{1}{4}$ in. thick, and the bottom flange is 24 in. wide by $2\frac{1}{4}$ in. Hence, the area of the girder at the end and joints is 182 sq. in., and in the middle 142 sq. in. The area of the bottom flange is 54 sq. in. throughout. The tension bar on each side is 6 in. deep by 2 in. wide, and therefore the two bars have an area or cross section of 24 sq. in. for each line of girders. Taking the smallest section of this beam, it will probably not be safe to use a higher coefficient than 1; hence, the breaking weight = $\frac{\mathrm{A}\ d}{l} = \frac{142 \times 36}{74} = 69$ tons, for the breaking weight of the cast-iron girder alone, without the tension bar.

According to Mr. Fairbairn's formula, the breaking weight of the cast-iron girder alone would be $\frac{54 \times 36 \times 2\cdot16}{74} = 56$ tons, and the breaking weight for the tension rods would be $\frac{24 \times 3 \times 36 \times 2\cdot16}{74} = 76$ tons.

Hence, the breaking weight of the whole girder complete, with tension bars, will be either 145 tons or 132 tons, according as we adopt one or other of the formula above used; but if it be true (as I believe it is, from Mr. Fairbairn's experiments,) that the truss rods only contribute a strength equal to one-third of 76 tons, then the breaking weight of one trussed girder will not exceed 92 tons, which does not seem enough for a span of 74 ft.

Computing the breaking weight of the trussed girder by formula (41) we have $\frac{36\ (142 + 48)}{74} = 92$ tons.

Cast-iron Bridge, with Tension Bars, over the River Dee, on the Chester and Holyhead Railway.

The failure of this bridge affords an example which it may be useful to examine. It fell under the weight of a passing train in May, 1847—an accident which probably contributed to cause the appointment of the famous Commission to inquire into the strength of iron in railway structures, whose labours I have already alluded to at some length.

This bridge consisted of three openings, each of 72 ft. span on the square, and 98 ft. on the skew. Each opening is covered by four lines of girders, the two centre ones being placed almost close together, and the two outer ones 12 ft. apart. Every line of girders over each opening is composed of three pieces, well secured by bolts and flanges at their junction, and strengthened by wrought-iron rods, which will pre-

sently be described. The depth of each girder is 3 ft. 9 in., and the dimensions and area as follows:—

Top flange	7″ × 2″	14
Rib	40 × 2	80
Bottom flange	24 × $2\frac{3}{4}$	66
Total area		160 sq. in.

The girders are strengthened at the ends and junctions, but the above is the section which must be considered in calculating their strength.

Every line of girders has on each side of it eight parallel plates of wrought iron, each 6 in. × $\frac{5}{16}$. These bars are disposed on each side of the girder so as to form a chain of three links, the upper extremity being suspended from a casting attached at the end and top of the girder, and the middle part of the chain being horizontal. The upper end, or point of suspension, is 7 ft. above the bottom of the girder, and the chain, therefore, declines 7 ft. in one-third of its entire length. The area of this chain for each girder is $6 \times \frac{5}{16} \times 16 = 30$ sq. in.

According to the formula $\frac{A\,d}{l}$, the breaking weight of one line of girders in the centre, is $\frac{160 \times 45}{98} = 74$ tons; and according to Fairbairn's formula the breaking weight is $\frac{66 \times 45 \times 2{\cdot}16}{98} = 64$ tons.

According to Mr. Stephenson's evidence on the inquiry which took place into this accident, the breaking weight in the centre of the girder would be 70 tons; and the engineers, Mr. Walker and Captain Simmons, who reported on the accident to the Board of Trade, calculated the breaking weight at 80 tons.

Messrs. Walker and Simmons appear to have considered what the strength of the cast iron should have been, if entirely unaided by the tension bars; and they came to the conclusion that the pair of girders supporting one line of railway should be capable of bearing a distributed load of 540 tons, so that the breaking weight of each girder in the centre would be $\frac{540}{4} = 135$ tons, instead of 64 to 80.

Let us now see what resistance would be given by the tension bars according to Mr. Fairbairn's formula. The area for each girder being 30 in., we have $\frac{90 \times 45 \times 2{\cdot}16}{98} = 89$ tons. Messrs. Walker and Simmons, however, only estimate the tension rods for one line of railway as capable of supporting a distributed weight of 260 tons, which is only equal to 65 tons in the centre.

Hence, according to Mr. Fairbairn, the entire strength of one girder would be represented by a breaking weight in the centre of $64 + 89 = 153$ tons; and according to Messrs. Walker and Simmons, the strength would be represented by a breaking weight in the centre equal to $80 + 66 = 146$ tons. Now the span being 98 ft., this breaking weight is only about $1\frac{1}{2}$ tons for each foot of span; whereas we have seen (page 268, of THE ARTIZAN, Vol. XV.) that the breaking weight in most of the Great Northern bridges is actually double this, or 3 tons per foot of span.

Either the Great Northern bridges are all unnecessarily strong, or this bridge on the Chester and Holyhead must have been most dangerously weak; since, even allowing the fullest value ever assigned to the tension rods, and assuming their resisting action to be perfect at all times, the bridge is only half as strong as those on the Great Northern Railway.

Messrs. Walker and Simmons, in their report, expressed very grave doubt as to the beneficial action of the truss rods; in fact, they threw out the very same suggestions as to the different extensibility of the two metals, which have since been so much enlarged on by Mr. Fairbairn. They state, as the result of their observations and experiments, that the tension rods probably acted at first and performed their share in strengthening the girder; but they are of opinion that when the girder gave way, the whole load was borne by itself alone. The following paragraph from their Report, will explain the view which they entertained as to the value of the tension rods.

"We have no evidence of the fact of the chains being loose, but we think it probable, that previous to the accident the girder might have been supporting the whole of the weight; and we fear that practically the tension bars are of but little use, or at least, that so little dependance is to be placed on them, that in a case of this nature the cast-iron girders ought to be of sufficient strength without them."

Notwithstanding several circumstances which are set forth in the Report, as affecting the strength of these girders, the load which actually broke down the bridge, must appear marvellously small. The engine and tender of the train which broke down weighed 30 tons; and the weight of the whole train, in addition to 18 tons of stone which were lying on the rails, does not seem to have exceeded 60 tons.

The bridge had frequently borne as heavy weights before without accident; and on the day it occurred, six trains had previously passed without any symptom of danger. The train which broke down, passed safely over the first and centre openings, and reached the middle of the third opening, when one of the girders gave way. Thus, allowing for a little concentration of weight under the engine, which, of course, is the heaviest part of the train, the breaking weight in the centre would not amount by calculation to more than 20 tons in the centre of the girder; whereas, by the lowest calculation, the girder alone should have borne more than 60. This example seems to show, not only that tension rods are extremely dangerous and not to be depended on in railway structures, but that the strength of the girder should be equal to at least six times the greatest load that can ever come upon it.

MR. HAWKSHAW'S BRIDGE OVER THE RIVER CALDER, ON THE WAKEFIELD, PONTEFRACT, AND GOOLE RAILWAY.

This is a skew bridge of three arches, each being about 50 ft. span on the square, and about 53 ft. on the skew face. Each girder is 31 ft. in length; and the bridge consists of three lines of girders. The six girders forming one line are laid with the ends closely abutting, so that each bay is spanned by two girders in length, and the two opposite ends of each girder rest, *one* on the pier, and the other in the centre of the span. Each girder at the end has the following dimensions:—

Top flange	8 in. × $2\frac{1}{2}$ in.
Bottom ditto	24 „ × $2\frac{1}{2}$ „

Central rib 2 in. thick; total depth of middle girder, 6 ft. 2 in.; and of the side girders, 5 ft. 2 in.

The girders at the centre have the following dimensions:—

Top flange	8 in. × $2\frac{1}{2}$ in.
Bottom ditto	24 „ × $2\frac{1}{2}$ „

Central rib 2 in. thick; total depth of middle girder, 4 ft. 8 in.; and of side girders, 3 ft. 8 in. Each girder has on each side of it a wrought-iron tension bar, or truss rod, 6 in. in depth, by an inch in breadth. In this bridge each rib, covering a single span, is composed of two pieces, or the span may be said to be covered by a built girder, in two pieces.

Calculation of the Strength of this Bridge.

The middle girder has an area in the centre as follows:—

Top flange	8 × $2\frac{1}{2}$	20 in.
Bottom ditto	24 × $2\frac{1}{2}$	60 „
Rib	51 × 2	102 „
Total		182 in.

The side girders:—

Top flange	8 × $2\frac{1}{2}$	20 in.
Bottom ditto	24 × $2\frac{1}{2}$	60 „
Rib	39 × 2	78 „
Total		158 in.

Thus, by Mr. Fairbairn's formula, the breaking weight for the middle rib is—

$$\frac{2{\cdot}16\,(60 + 12 \times 3)\,56}{53} = \ldots\ldots\ 220 \text{ tons}$$

And for the side rib—

$$\frac{2{\cdot}16\,(60 + 12 \times 3)\,44}{53} = \ldots\ldots\ 173 \text{ „}$$

Breaking weight for one line of way .... 393 tons

or $196\frac{1}{2}$ tons for each line of rail, being less than 4 tons per foot of span.

By formula 41, the breaking weight for the middle rib is—

$$\frac{56\,(182 + 12 \times 2)}{53} = \ldots\ldots\ 217$$

and for the side ribs,

$$\frac{44\,(158 + 12 \times 2)}{53} = \ldots\ldots\ 151$$

For both girders.................... 368 tons

MR. HAWKSHAW'S BRIDGE OVER THE KNOTTINGLEY AND GOOLE CANAL, ON THE WAKEFIELD, PONTEFRACT, AND GOOLE RAILWAY.

This is a skew bridge of 77 ft. span on the square, and 88 ft. on the skew face. It consists of four girders, each cast in three lengths. The depth in the centre is 4 ft. 6 in., and the following are the dimensions:—

Top flange	8 × 2	16
Bottom ditto	24 × $2\frac{3}{4}$	66
Rib	49 × $2\frac{1}{4}$	110
Total area		192

The depth of the pieces at the ends, and where bolted together, is 7 ft. 6 in.

Each compound girder has a single line of three tension bars on each side, with an area of 7 in. by 1 in. = 14 in. for each girder. The breaking weight of this girder, by Mr. Fairbairn's formula, would be $\frac{2 \cdot 16 \times (66 + 42)\ 54}{88} = 144$ tons; and as this is probably much in excess of the real strength of the bridge, there does not appear to be much margin for contingencies.

Calculated according to formula 41, the breaking weight in the centre is only $\frac{54\ (192 + 28)}{88} = 135$ tons.

Mr. Hawkshaw has built, in the North of England and elsewhere, a number of other bridges on the same principle.

Mr. Fairbairn's experiments, already quoted, were made on beams having trusses with only one angular point; but in most of the large cast-iron trussed girder bridges, the truss has two angular points, being in three pieces, the middle of which is horizontal.

It is probable this is a worse form than the truss with one angle, and more unlikely to realise a simultaneous action in the two metals. Experiments have been made by Professor Barlow on trusses acting by compression, from which it appears that no increase of strength is gained by queen-bolt trusses of this description. A similar result was found in some very elaborate experiments made in America on inverted trusses, or those acting by tension.

Wooden beams, trussed in various forms, were experimented on, when it was found that no strength whatever was gained by using trusses with two angular points; but in trusses with one angular point an increase of strength equal to 50 per cent. was gained in certain cases, where a simultaneous resistance was obtained.—(See "Journal of the Franklin Institute," 1842.

REPORT OF THE RESULT OF OBSERVATIONS UPON THE DEPOSIT OF SILT IN THE HARBOUR OF NEW YORK.

By Charles H. Haswell, Civil and Marine Engineer.

[Made during the years 1854–1857.]

New York, Dec. 21, 1857.

Sir,—In the summer of 1854, I verbally called the attention of the late President of your Board, Walter R. Jones, Esq., to the wash of earth from the streets and sewers of this city and Brooklyn, into the slips bordering thereon, by which not only this harbour was being injuriously affected, but that the width of the channel inside of the bar at Sandy Hook had become seriously narrowed, and ultimately the depth of water on the bar must become lessened; and that, in view of the great interests that would be affected by any reduction of the depth of water there, it was proper that some investigation should be made of the extent of the deposit of *silt* into the rivers bordering our city, for the purpose of placing the results before the public, in order that its attention might be directed to the consideration of an element in our commercial position, secondary to none other, viz., the maintenance of a depth of water at the entrance of our harbour equal to the full requirements of our commerce.

Mr. Jones readily entertained my proposals, and under his direction I at once proceeded to make such observations as I thought best calculated to furnish the essential elements in the case, restricting myself to the subject of deposits in our harbour; the encroachment upon the boundaries thereof, by the extension of bulkheads and piers, and the injurious effects therefrom, I did not propose to consider, for the two-fold fact, that the necessity of restraining these encroachments had become so manifest to the public, that not only had the attention of our Legislature been called to the subject, but that it was then receiving the consideration of a committee appointed for the purpose of investigating and reporting thereon; and secondly, that the operation of such encroachment was so similar to that which I proposed to investigate, viz., the reduction of the tidal volume of our harbour, that the deductions in one case would be equally applicable to the other.

As a prelude to my task, I assumed it to be indisputable that the bar at Sandy Hook, in its general features, like the bars of all tidal rivers, presented a series of irregular obstructions stretching across the entrance into the lower bay, with a varying and less depth of water upon it than in the channels within it.

The causes admitted to produce this general result are numerous, but the following apply, in my opinion, peculiarly to the locality under consideration:—

1st. To the arrest of the current of the last of the ebb tide from the bay, where it meets the first of the sea flood when it surrenders the *detritus* it holds in suspension.

2nd. To the difference of the flood and ebb currents in their direction.

3rd. To the action of ground swells from the sea, which, if heavy and flowing from the southward and eastward, deposit sand and gravel upon the bar, and at all times, when aided by the current of the flood, within the entrance thereof.

4th. To the occasional diminution of the back water of the bays and rivers leading thereto from drought, and the reduction of the tidal volume by the presence of ice upon flats and the shores.

5th. To a reduction of the tidal area by the constant accretion of *detritus* upon the shores.

The first three positions are similar in a great degree to those entertained by E. K. Calver, R.N.; the 5th one by Sir Henry De la Beche.

In the prosecution of my observations I selected sixteen locations which I thought best suited to furnish me with the elements desired, and provided myself with an equal number of bottles, of like capacity (30 cubic inches). I repeatedly filled one of them with water from each of these localities at half tide (both ebb and flow), both in dry and wet weather, and at different seasons of the year; such water was then filtered and the residuum weighed and noted in grains, the average results of which, deduced from the operations of several years, furnish the following:—

Weight, in grains, of deposits in 30 cubic inches of water from the following localities:—

	Grains.		Grains.
Sandy Hook	·109	Manhattanville	·578
Narrows	·265	Harlem Bridge	1·031
Robbin's Reef	·367	Hell Gate	1·093
Ellis' Island	·811	30th Street East	1·265
Battery	1·687	23rd Street East	2·968
Liberty Street	6·927	Grand Street	4·000
Canal Street	8·531	Wall Street	5·187
30th Street West	·937	Broad Street	6·375

The mean result of which is 2·633 grains in every 30 cubic inches of water.

Excluding therefrom all the city localities, but one upon each side of it, for the purpose of arriving at a mean of the average presence of *silt* in the water of our harbour above the Narrows, the following result is obtained:—

	Grains.		Grains.
		Brought forward	3·130
Narrows	·265	Manhattanville	·578
Robbin's Reef	·367	Harlem Bridge	1·031
Ellis' Island	·811	Grand Street	4·000
Battery	1·687	30th Street West	·937
	3·130		8)9·676
			1·209

From which it appears that the average annual flow of *silt* into the rivers bordering this city, reaches the enormous rate of 1·209 grains in every 30 cubic inches of water; and assuming the quantity of the former to be equal to 125 lbs. per cubic foot, a cubic inch of it will weigh ·072 lbs. The volume of this deposit compared with water is, therefore, as 1 to 12,565.

Confining my observations to the city of New York alone, and taking the deposits shown in the water from the several localities around the city, the mean amount of *silt* in every 30 cubic inches of water is as follows:—

Battery	1·687
Liberty Street	6·937
Canal Street	8·531
30th Street East	1·265
23rd Street East	2·968
Grand Street	4·000
Wall Street	5·187
Broad Street	6·375
30th Street West	·937
	9)37·887
	4·209

Hence, by the elements before given, it appears that the volume of the deposit from the water in the slips of this city between 30th Street East and West and the Battery, compared with that of the water (at half tide), is as 1 to 3,610.

Startling as these results appear, it must be borne in mind that they do not give a full exhibition of the facts of the case, for the observations made were necessarily confined to the presence of *silt*, and embraced only that portion which was retained in suspension by the flow of currents, whilst the deposit of *detritus* from the flow of gravel, sand, &c., could not be arrived at, unless by a different system of observation, and it is consequently not embraced in the above results.

The detractions from these results to be taken in view, are—

1st. That the strength of the current at certain points is sufficiently rapid to keep much of the *silt* in motion at both the ebb and flow of the tide; hence, although its presence is shown, yet its rapid deposit does not occur.

2nd. That the water taken from the several locations between 30th Street, on each side of the city, was taken from between the piers; and although the deposit of *silt* noted, is just as regards the location from where the water was taken, a greater deposit is exhibited than if taken from the ends of the piers; this, however, does not affect the results here given, but refers only to the extent of the area of deposit.

In corroboration of these results, and in illustration of the effects under consideration, the proprietors of the N. Y. Sectional Dock assure me that the deposit of *silt* upon their tanks between the piers of Market and Pike streets, averages full five-sixteenths to three-eighths of an inch in one flow of tide, and they are thereby subjected to the delay and cost of dredging under their dock to the depth of seven feet every two years.

In illustration of the effects of a reduction, by the encroachments upon our rivers, and the deposit therein, of the quantity of water which flowed into our harbour, the flood-tide through the East River and Hell Gate, once flowing to Sand's Point, is now arrested at Fort Schuyler; the width of the ship channel inside of the bar had narrowed in 1855 half a mile, since the survey of 1836; by a report of A. Boschke, of U. S. Coast Survey, made to Professor A. D. Bache, the Superintendent thereof, it appears that in the main ship channel alone, from the S. W. Spit to Gedney's Channel, there has been an actual deposit

in twenty years of a volume of sand of 2,532,600 cubic feet; and from the late report of the Harbour Commissioners, made to the Legislature of the State, it appears that the Jersey Flats are rapidly silting up.

This is, in my opinion, an alarming exhibition, and one involving considerations demanding the immediate attention of all who feel interested in the commercial interests of this city; for without remedial action the width of the channel and depth of water on our bar will become so reduced as to preclude the admission of vessels of the largest size into our harbour.

The course of remedial action most readily and effectually introduced at this time that occurs to me, is the effective cleaning of our streets and piers, in order to remove the wash into the rivers therefrom, and putting an end to the present practice of depositing the dredging of our slips into the channel of the rivers: and I opine that no one who gives the subject his attention will for a moment permit the temporarily increased expenditure consequent upon the measure here suggested to be weighed for a moment, or in value with the advantages to be derived therefrom.

The operation of dredging slips as now performed is briefly as follows:— The deposits in the slips are removed to the channels of the north or east rivers, when the *silt*, or mud, is swept by the current of the tide back to the slips, and upon the flats of New Jersey and Long Island, and the stones, bricks, and such other matter too heavy to be moved by the detrital action of the current, fill the channel in proportion to their volume.

The opinion appears to prevail with the public that the discharge from our sewers, and the deposit removed from the slips into the rivers, are *washed*, as it is termed, into the sea and Long Island Sound: if this were the operation it would be well for the interests involved in the subject under discussion; but, as it happens, a very brief examination of the case presents a very different result. Thus, the deposits in our slips, *i.e.*, mud, independently of stones, bricks, &c., is composed of gravel, sand, clay, and feculent matter, which, when transferred to the channels of the rivers, is submitted to the detrital action of a current of from three to four knots per hour, 18 miles distant from the sea; with these elements, then, it would be difficult to show how any portion of this mud, other than the soluble part of it, and the colouring matter therein, could ever reach Sandy Hook.

A review, then, of the elements submitted, and a consideration of their operation furnishes, the following deductions:—

1st. That the deposit of *silt* and *detrital* matter into the rivers bordering this city is so considerable in amount that the slips of this city are very rapidly being filled; the bays, indentations, and flats upon the shores of Long Island and New Jersey, the Harlem River, and all places where the currents are comparatively feeble, are being rapidly silted up by the tidal currents, and along with the accretions of the wash upon the shores of our harbour, the tidal volume thereof is being reduced, upon the extent of which tidal volume depends the volume of water passing the bar at Sandy Hook, a point involving the commercial value, if not the physical existence, of this harbour.

2nd. That the system of the dredging of our slips as now pursued, viz., the removal of the deposits therein from below low-water depth, to be exposed to the currents in the rivers, ends in but a transfer of them to other slips and shoal places; the effect of which is to involve the loss of time and cost of a re-removal of the deposits from the slips.

3rd. That by the thorough cleaning of the streets and piers of this city, Brooklyn, and neighbouring cities, that the deposits into the slips would be lessened, and the necessity for dredging them would be rendered less frequent.

Finally. That economy in the current expenditures of cleaning our streets and dredging slips, demands that the streets and piers of our city should be thoroughly cleaned, and that the transfer of the materials dredged from our slips to the channel of the rivers should be forthwith forbidden, since the increased cost consequent upon the removal of the mud to the main land, is quite inconsiderable compared with that of its repeated removal by being deposited in the channels of the rivers.

In order that I may not be subjected to the charge of attaching too much importance to this subject, I beg leave to submit a few of the results of investigations held by the Tidal Harbour Commission, &c., &c., &c., in England, together with the opinions of the necessity of the maintenance of the tidal volume in all maritime ports, as furnished by Calver in his invaluable work upon "Tidal Rivers," whose *thesis* is, "That the navigable condition of the outlet of a tidal river can only be maintained by tidal water, and that its extent as to sectional capacity will be proportioned to the amount admitted."

"We consider the magnitude of every tide harbour, both as to width and depth, is generally proportionate to the quantity of such flowing and reflowing water, and every subtraction from such quantity by embankment tends to decrease the magnitude of the outlet to the harbour." [*Rennie and Jessop. Report on Rye Harbour.* 1801.]

"I am not aware that any remedy can be substituted for the deprivation of back-water." [*Rennie. Report on Southwold Harbour.* 1820.]

"It is not to be forgotten that as the sands and mud accumulate, and marsh lands are formed in the upper part of the estuary, the power of scouring the lower portions (the eutrance) is diminished." [*Telford. Report on river Dee.* 1821.]

"If there were no receptacle for tidal waters to pass in and out at every tide, the harbour would cease to exist." "If with the same width between the piers, we reduce the quantity of water which has to pass in or out in the same time, we diminish at once the required velocity or power to remove obstructions, and a decrease of depth follows almost immediately." "It is to be lamented that when the owners of estates were, perhaps, balancing in their minds whether the land they could reclaim would pay the expense of reclaimig it, they were not advised of the injury they were about to do to the public and themselves by a reduction of the back-water, upon which their harbour is dependent." [*Walker. Report on Southwold Harbour.* 1841.]

"Liverpool, Yarmouth, Montrose, and many of our great harbours, depend for their existence upon the tidal current, and therefore the receptacle for tidal water ought to be preserved with jealous care." [*Walker. Report on river Tay.* 1845.]

"*Q.* Are the Commission to understand that enclosures stopping the flow of tidal water, must gradually injure the bar of the harbour to which that formerly served as a scour?

"*A.* Yes, it will do so." [*Cubitt. Evidence before Tidal Harbours Commission.* 1845.]

"As the maintenance of the navigation and the keeping down the bar depends mainly on the quantity of water passing over it, * * * * * care should be taken that no further embankments over which the tide is accustomed to flow, be permitted. * * * On the contrary, care should be taken to increase, either in width or depth, the space for the reception of tidal water." [*Sir John Rennie. Report on Wexford Harbour.* 1831.]

"I think that any effect from a fresh at the bar is a mere bagatelle compared with the scouring of tidal water." [*Leslie. Evidence before Tidal Harbours Commission.* 1845.]

"*Q.* Are you of opinion that depths in rivers and their power of scouring are chiefly due to the volume of water brought down in freshes, or to the tidal waters? *A.* I should say to the tidal waters." [*D. Stevenson. Evidence before Tidal Harbours Commission.* 1845.]

"I do consider it highly injurious to any river to shut out even 1 in. of the tidal water." [*Bald. Evidence before Tidal Harbours Commission.* 1845.]

"The area of the estuary of the Dee was formerly about 12,000 acres, covered at every spring tide; of this space 8,000 acres have been enclosed, and the tidal water excluded. The Act of Parliament that sanctioned this extensive encroachment required that a depth of 15 ft., at ordinary spring tides, should be maintained up to Chester; but the river was in so bad a state in December, 1844, that a vessel drawing only 8½ ft. water could not go up to Chester on a spring tide."

"At Parkgate, 12 miles below Chester, which formerly was one of the principal mail packet stations between England and Ireland, a dry sand now extends almost across the estuary." [*Second Report of Tidal Harbours Commission.* 1846.]

"Blakeney and Clay, on the north-east of Norfolk, have a common entrance from the sea, within the memory of some of the present pilots; 140 coasting vessels have taken refuge in this port during one tide; yet in the place where these vessels lay afloat at low water, there is now only a depth of 4 or 5 ft., and the utility of the harbour has consequently been almost destroyed."

"It is stated that this evil has been caused by the enclosure, at different times, of more than 1,200 acres of land, over which the tidal waters formerly flowed." [*Second Report of Tidal Harbours Commission.* 1846.]

"Rye Harbour has been ruined by embankments; it appears in evidence that formerly a 64-gun ship could use that harbour, which is now ruined." [*Rennie. Evidence before Rochester Bridge Committee.* 1820.]

"Mr. Walker states in evidence before the Tidal Harbours Commission, 'the diminishing the reservoir for the tidal water in the Thames has had, in my opinion, the effect of increasing the shoals at its mouth;' and Mr. Abernethy, in his report upon the Dee, the enormous obstructions from which river we have already noticed, remarks, 'the lower portion of the navigation is gradually filling up;' thus proving the correctness of Telford's prediction."

Further. The fatal error of a common opinion that the flow of water from the Hudson River by freshets, is all sufficient to keep the bar at Sandy Hook navigable, is thus dissipated by elements furnished by Mr. Walker, in his evidence before the Tidal Harbours Commission.

In the Tay, the discharge, including that of the Earn, amounts during freshets to one million cubic feet per minute, or 240 millions during four hours. The tidal water passing Dundee in the same time is above 7,000 millions, or thirty times that of the river water, and making the calculation at the bar, the tidal water is upwards of forty times that of the river water. It is well observed by Mr. Walker, that it is only when the quantities are reduced to figures in this way that the vast disparity is seen; and by Mr. Leslie, who says that any effect from a fresh at the bar is a mere bagatelle compared with the scouring of the tidal water.

Now, if this test of a measurement of the proportionate flow of the tide and of the freshets were made in the Hudson or Delaware, or any other of our tidal rivers of magnitude, a much greater disparity would be found to exist; for in this country, where the annual fall of rains is much below that of England, the volume of the river freshets would be proportionally decreased, which, when estimated in connection with the *datum* of Mr. Walker, above cited, would be conclusive as to the inefficiency of the scouring of a freshet, in comparison with that of the flow of the tides.

Regarding the effect of the presence of ice in a harbour, it must not be lost sight of, that although ice in suspension in the water does not reduce the tidal volume, other than by presenting a resistance to the surface current of the tidal flow, that when it is fixed, as when upon flats and shores, that it reduces the tidal volume in direct proportion with its own.

Trusting that the results furnished and the views here given will meet with your approbation, and a concurrence in the opinion as to the importance of the subject,

I am, very respectfully,
Your obedient servant,
CHAS. H. HASWELL,
Engineer.

A. B. NEILSON, Esq.,
President Board of Underwriters, New York.

INSTITUTION OF CIVIL ENGINEERS.

January 26, 1858.

JOSEPH LOCKE, Esq., M.P., President, in the Chair.

The papers read, were "ON SHEARING, PUNCHING, RIVETTING, AND OTHER SIMILAR MACHINERY EMPLOYED IN THE MANUFACTURE OF STEAM BOILERS," and "ON THE SELF-ACTING TOOLS EMPLOYED IN THE CONSTRUCTION OF STEAM ENGINES, &c." By Mr. T. S. Sawyer.

In the first paper the author proceeded to describe the comparatively rude machinery employed, until within a recent period, in the construction of boilers; such as the arrangement for punching plates, which consisted of a punch simply mounted in guides, the matrix being secured in a block below, and the necessary force for the operation being the blow from a hammer. This was superseded by a lever raised by an eccentric cam. The introduction of more improved machinery was then particularly noticed, and the various arrangements of apparatus for punching and shearing vertically in one machine described, those manufactured by Messrs. J. Whitworth and Co. being instanced.

An account of the machinery for rivetting was then given, and it was considered, that the introduction of the direct action of steam for this purpose was most important, and that the arrangement of a separate engine to work each machine had proved to be more advantageous than working several machines by straps, gearing, &c. A brief description of the machinery for forging rivets, &c., was then given, and by one example it was shown that a ton of well-formed rivets, all exactly similar, could be produced in ten hours. The machinery for forging bolts and other similar articles was then described, together with the various arrangements of air-hammers suitable for larger work—the principal feature of which consisted in allowing a hammer or block to fall by its own gravity against the pressure of air in a cylinder, so as to produce an elastic blow. The mode, however, generally adopted for lifting the piston and hammer was not considered satisfactory, as it produced a jarring action, which soon caused deterioration to the machine. An arrangement of apparatus was also described for forging nuts of various sizes with exactness, the plan introduced by Messrs. Collier being particularly alluded to and explained, samples of the nuts so made being exhibited. The author thought that there was yet much to be accomplished by a further introduction of machinery in the construction of boilers, so as to insure correctness of form and detail.

With regard to the "Self-acting Tools employed in the construction of Steam Engines and other machinery," they were thus classified and described:—

First.—The machines employed in the construction of steam engines.
Secondly.—Those used in the manufacture of general machinery, including that employed in cotton mills.

The tools employed in the construction of steam engines were again divided into the following sections:—
First.—Drilling, boring, and other similar machines.
Secondly.—Turning and screw-cutting machines.
Thirdly.—Shaping, planing, slotting, and key-grooving machines.

After describing the simplest form of drilling machines, the author proceeded to point out the advantages of the radial drill, together with the great ingenuity displayed in the motion for producing the feed. The arrangement of mechanism for producing the feed in the large machines for operating upon the cylinders and air pumps of steam engines was then particularised, with the system of wheels required for this purpose. Other modifications of these tools, as applied in the manufacture of cotton machinery, was then noticed.

Under the second section the various arrangements of lathes, such as those employed in ordinary turning and screw cutting, the break lathe, and those introduced by Whitworth, in which two or more tools or cutters were adopted on opposite sides of the centres, were minutely described.

In the third section a detailed description of the shaping and slotting machines was given under the following heads:—

First.—Shaping, in which the tool was mounted so as to be adjustable to various angles.
Secondly.—Those in which a varied speed of the cutting tool was adopted, and the work to be operated upon traversed vertically, or horizontally. The slotting machines, in which the cutter traversed vertically, and in which the table or rest was adjustable for the feed, were described. The various purposes for which they were used were also referred to.
Thirdly.—Planing machines, with the apparatus for adjusting the tool or cutter, and the means adopted for effecting the required change of the traversing table, together with the driving medium.

The author stated that great advantages had resulted from the introduction of labour-saving machines; a better class of work was produced; and although it had often been urged against the use of such machines, that employment for workmen would be diminished, yet in no instance had this been found to be the case. It had, however, a tendency to render lighter the labour of the workman, and to stimulate him to become more a master of his art, as well as allowing more time for mental improvement.

In the discussion, it was remarked that Mr. Richard Roberts had been one of the earliest introducers of self-acting tools, such as the planing, slotting, and machines for metals. Within the last few years he had also made improvements in punching and rivetting machines. His "Jacquard," or multifarious perforating machine, was now employed at the Canada Works, Birkenhead, for punching the boiler plates to be used in the construction of the Victoria Bridge over the River St. Lawrence, Canada. The machine was now punching seventy-two holes in each plate of 10 ft. in length, 3 ft. 6 in. in width, and 5-16ths in. in thickness. It could punch ninety of these plates per day of ten hours and a half, under the management of one mechanic, three labourers to lift the plates on and off, and one boy to oil the punches. The same sized plate, when punched by hand, would require four men marking with templates, and eight men at the machine itself—and yet it would not do anything like the same quantity of work as the Jacquard machine, especially when a large number of holes had to be made. The dies and punches in the Jacquard machine, when fairly at work, were also less costly. Specimens were exhibited by Mr. Roberts, of what he termed spiral planing—and Messrs. Batho and Bauer showed models explanatory of their reciprocating drilling machine and small planing machine, in elucidation of the descriptions given in the paper. It was shown, that by five of these improved planing machines, as much work could be done as by six of the ordinary machines.

The reciprocating drilling machine was stated to have been very successfully used at the manufactory of Messrs. Robert Stephenson and Co., where an improvement had been introduced by the addition of a rocking frame, by means of which the machine could cut taper key holes, in piston and other rods; and now all the key-holes were made to one given angle best adapted for drawing and holding.

It was noticed that to Maudslay, Clement, and Bramah, was due the praise of nearly the first introduction of self-acting tools. Then came Fox (of Derby), Whitworth, and Roberts, and recently a great number of very ingenious inventions had been brought forward by the numerous makers, whose names were now so well known.

The ingenious machinery for punching boiler plates, invented nearly forty years ago by Mr. Maudslay, for making water-tanks for the navy, was described; and it was shown that up to the present time that same machinery was almost unrivalled for the precision of its action and the quantity of work it performed.

It was stated that great care should be exercised in the use of rivetting machines, as, if undue pressure were employed, the rivets were too much compressed, and instances were given of plates being split throughout their length, under the process of rivetting. On the other hand it was shown that Garforth's steam rivetting machine could, by the careful adjustment of the dies, be rendered a most efficient and valuable adjunct in making boilers.

Instances were adduced of the great accuracy to be attained by the use of self-acting tools; and as an instance of the economy thus introduced, it was stated that a surface of iron for the chipping and filing of which, by hand, a clever workman was formerly paid twelve shillings, was now ordinarily done by the planing machine for three halfpence.

The subject was so large, and so very interesting, that it was hoped a paper would be given on the history of the introduction of these self-acting tools, which had produced such a revolution in the manufacture of machinery.

February 2, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

The paper read, was "On the Methods generally adopted in Cornwall, in Dressing Tin and Copper Ores," by Mr. James Henderson, Assoc. Inst. C.E.

The author introduced the subject by stating, that since the paper by the late Mr. W. J. Henwood, read before the Royal Geological Society of Cornwall, in October, 1828, he was not aware of any detailed account of such operations having been brought under the notice of the public. This might, probably, be accounted for by the fact, that very few improvements had, during late years, taken place, in either the dressing of tin or of copper ores. It was to be regretted that Mr. Henwood's able paper had not been illustrated by diagrams, so necessary in matters of detail. These, the author of the present paper endeavoured to supply. He felt much indebted to the kindness of the agents of St. Day United Mines, Carn Brea, Porkellis, Tin Croft, Par Consols, and North Basset Mines, in permitting a minute inspection of the whole of the machinery under their management, and from which many of the illustrations were derived.

In the account of tin dressing, the operations were described in detail, commencing with the "spalling," or breaking up the ore with hammers, as it came up from the mine to the surface. Then "vanning," or testing the value of the ore, by bruising on a shovel and agitating with water a small portion from the pile. The difficulty of separating the wolfram, or the tungstate of iron and manganese from the tin ore was then commented on.

The "stamps," so indispensable to every tin mine, were then minutely described. In some of the large tin mines in Cornwall, as many as one hundred and four stamp heads were driven by one steam-engine. The importance of attention to the suitable size of the holes in the "stamp grates" was noticed, as on that point depended entirely the degree of fineness, to which the ore would be pulverised. After a description of the "strips," into which the ore in the shape of fine sand and water passed on leaving the stamps, it was stated that the ore was divided in the strips into three parts—the "head," "middle," and the "tail." The "slime," forming a fourth portion of the tin stuff, passed into another pit. The operations buddling, tossing, and packing, to which the "head" or "crop" was subjected, were then described.

The "middle" of the strips was then followed through the various manipulations to which it was subjected. Circular buddles were also described.

In describing the dressing of the "tail" of the strips, the ordinary "Separator" was explained, as also Wilkins' Separator, which was strongly recommended for its great efficacy and cheapness. The methods of "trunking" and "framing" were then described. An excellent though expensive arrangement of frames, used at St. Day United Mines, was explained, and also a novel construction of hand frame.

The burning-house operations were then detailed, and a description was given of the calcining now gradually coming into use in the Cornish Mines; with an account of the arsenic-flues, through which the fumes from the oven or calciner were made to pass. "Chimming" and "dilluing" were then described; thus completing the dressing operations of tin ore.

The operations of dressing copper ore were much more simple and less numerous than those of tin dressing. The revolving "griddle" was explained, as also the process of "bucking;" and the "Crusher" machine, which had superseded the bucking mill, was described, as well as the methods of "cobbing" and "picking."

Several "jigging" machines were described, and minute details were given of "Petherick's Separator," with a tabular statement, clearly showing the superiority of the latter over the old fashioned machines. It was a matter for surprise that so valuable a machine was scarcely known in the West of Cornwall.

The whole of the numerous operations detailed, were fully illustrated by a series of large and interesting diagrams on a scale of one inch to the foot.

At the monthly ballot, the following candidates were duly elected:—Mr. W. H. Bartholomew, Member, and Messrs. J. F. Churchill, R. Downing, W. J. Kingsbury, G. Lyon, J. M. Sleater, and W. W. Wardell, Associates.

February 9, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

The discussion upon Mr. Henderson's paper, "On the Methods generally employed in Cornwall, in Dressing Tin and Copper Ores," was continued throughout the evening.

In commencing the discussion, allusion was made to Oxland's process for removing wolfram from tin, as practised at the Drake Walls Tin Mine. The tin stuff being roasted with soda, the wolfram combined with it, and formed tungstate of soda, which being soluble in water could be easily removed. This was important, as it appeared probable that tungsten would be, by Jacob's process, rendered available in the manufacture of steel, and would also be used in the arts generally.

It was stated that the universal feeling among the better informed "dressing Captains" in Cornwall was, that the present methods of dressing ores, requiring such a large proportion of manual labor, were a reflection on the mechanical progress of the age. Mention was made of Mr. Herbert Mackworth's machine for washing coal, by a slow, continuously ascending current of water. The machines, six of which had been set to work since May, 1857, were said to be almost automatic. The difference in the specific gravity of shale and coal being as 2·6 to 1·3, there would evidently be less difficulty in separating the ordinary minerals of Cornwall, and experiments on a small scale promised successful results.

Allusion was made to the machine for washing coal, introduced into this country by Monsieur Bérard, of St. Etienne, at the period of the Great Exhibition, in 1851, when a Council Medal was awarded to it. Improvements had already been made in it by Petherick, and this latter machine had been already improved upon by Edwards, whose machine consisted of two cisterns, each having in their side an aperture covered by a flexible diaphragm, which could be projected inwards by a connecting rod having a stroke of 6 inches. This motion pressed upwards the mass of water in the cistern, projecting it through the gratings covering the cisterns, upon which the coal was consecutively laid in a film. The coal, being of less specific gravity than the shale and pyrites, was, by the action of the water beneath, pressed upwards, and was removed by scrapers having a slow motion, whilst the heavier particles fell through the gratings into the cisterns below. In extracting ores the reverse action occurred, the valuable portions falling into the cisterns, whilst the lighter refuse was washed away from above the gratings.

Various improvements in the ordinary machines were suggested, and regret was expressed that machinery generally was not in the advanced state in Cornwall that was desirable for the treatment of such valuable minerals. It was stated that the utmost nicety was required in the separation of metal from the ores of tin and of copper, especially as in the case of the latter mineral, the present average quantity of metal extracted did not exceed 6 per cent. of the quantity of ore raised. Instances were given of only $17\frac{1}{4}$ lbs. and $17\frac{7}{10}$ lbs. of tin being extracted from each ton of ore raised, and yet from that apparently small return an adequate profit was made.

The coal-washing machine was stated to have been originally invented in the North of England, and to have been introduced into the West of England by Mr. John Taylor, by whom it had been adapted as a separator for the ores of tin and copper. The deficiencies of the present processes in Cornwall were admitted, and it was suggested that the great point was to continue the crushed and triturated stuff from the stamps in constant progress onwards, through all its stages, so that the mass should not be allowed to come to rest; this, it was urged, was very practicable, wherever there were copious supplies of water, and the machinery was improved with that object in view. Upon this principle the success of the coal-washing machine was based. Great improvements had been introduced into the machines in the Austrian mines, and very successful results had been obtained. It was shown that it was not desirable to reduce some ores to too fine a powder; this error had been committed in some of the gold crushing mills, and to this cause must, in some degree, be attributed the failures that had occurred during the gold mania.

It was practicable to extract with profit minute fractions of gold from a poor matrix. A mine in Hungary was instanced, whence, from a depth of 200 fathoms, the gold matrix was raised, and so skilfully manipulated as to work at a profit, although only producing one-tenth of an ounce of gold from a ton of the matrix.

The great merit of Mr. Henderson's paper was generally admitted, and it was hoped that it would be followed by other papers descriptive of the improved crushing and other machines, which required to be more generally known.

February 16, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

The paper read, was "On Submerging Telegraphic Cables," by Mr. J. A. Longridge, M. Inst. C.E., and Mr. C. H. Brooks. The authors desired their attempt to investigate the laws, to which the operation of submerging telegraphic cables were subject, to be considered only as a partial solution of an interesting and somewhat complicated problem. It was evident that much misapprehension existed on the subject, and it had been stated in the journals relating the proceedings at the meeting of the British Association at Dublin, in the year 1857, that "it seemed to be universally admitted that it was mathematically impossible, unless the speed of the vessel, from which the cable was payed out, could be almost infinitely increased, to lay out a cable in deep waters, say two miles or more, in such a way as not to require a length much greater than that of the actual distance, as from the inclined direction of the yet sinking part of the cable, the successive portions payed out, must, when they reach the bottom, arrange themselves in wavy folds, since the actual length is greater than the entire horizontal distance."

It was desirable to ascertain how far such a proposition was correct, and if correct, what amount of "slack," or of surplus cable should be provided to meet the waste, in varying depths of water.

The questions discussed in the paper, and of which the mathematical investigations were given in an appendix, were:—

1. The possibility of laying out a cable straight along the bottom, in deep water, free from the action of currents.
2. What degree of tension would be required in the process?
3. What would be the effect, as regarded strain, under the varying circumstances of the depth of water, of the specific gravity of the cable, and of the velocity of the paying-out vessel?
4. What would be the relative velocities of the cable and of the paying-out vessel, requisite to reduce the strain, or tension to any given amount, and what would be the consequent waste of cable?
5. The effect of currents, and the consequent waste of cable.
6. How far it would be necessary, or safe, to check the velocity of paying out, when passing currents, so as to avoid, as far as possible, waste of cable?
7. Would it be safe, and if so, under what circumstances, to stop the paying-out, and to attempt to haul in the cable from great depths?
8. The effect of the pitching of the vessel in a heavy sea.
9. The principal desiderata in the paying-out apparatus.
10. The effect of floats, or resisters.
11. The best means for saving the cable, in case of fracture.
12. The best mechanical construction of a submarine cable.

After investigating the laws of bodies, such as cables, sinking in a resisting medium, the paper proceeded to show the great waste of cable attendant upon paying out free from tension at the ship. The form of the curve assumed by a descending cable was then examined, and the amount of tension at the paying-out vessel, requisite to lay the cable without slack along the bottom, estimated under various conditions. The effect of the friction of the water in decreasing this tension, and the result, as regarded the tension, of increasing the velocity of the cable beyond that of the ship, were then pointed out. It was shown, that the decrease thus obtained was of small amount, unless the speed of the paying-out vessel was considerable, and that a decrease of tension should rather be sought in a diminution of the specific gravity of the table.

The tension at the ship in 2,000 fathoms water was stated to be about 35 cwt. for a cable similar to the Atlantic cable, but with a cable of the specific gravity of 1·5 it would not exceed $7\frac{3}{4}$ cwt.

The effect of currents was then considered, and it was maintained that they did not bring any additional strain upon a cable, and involved only a small loss of length on first entering them. In a hypothetical case of a current extending to a depth of 200 fathoms, and running with a velocity of $1\frac{1}{2}$ ft. per second, at right angles to the ship's course, it was calculated that the extra length of cable due to the deflecting action of the current would not exceed 28 fathoms, the velocity of the ship being 6 ft. per second.

The effect of stopping the paying out was next treated of, and it was shown that it would be to bring a very heavy catenarian strain on the cable, depending upon the depth of water, and the velocity of the paying-out vessel. The amount of this strain for the Atlantic cable in a depth of 2,000 fathoms, and at a velocity of the paying-out vessel of 6 ft. per second, was calculated at above 7 tons.

The question of hauling in the cable was then adverted to, and the conditions under which it might be safely attempted, were pointed out.

After discussing, briefly, the effect of the pitching of the vessel upon the strain of the cable, the paying-out apparatus was referred to; and the importance of reducing its inertia, and of so constructing the brakes that they should act freely, was maintained. Two plans were then mentioned for saving the end of the cable in case of fracture, and tables were given, showing the velocity and direction taken by the end of the cable under such circumstances.

The authors then proceeded to offer some remarks upon the mechanical structure of the cable, and strongly advocated a light cable. The distinguishing feature of this system of construction was, that the whole of the metallic portion was placed in the centre, and was surrounded by the insulating material; whereas, in the Atlantic cable, there was an outer sheathing of wire rope twisted spirally round the insulating medium. It was shown that whilst the absolute weights of the two cables were as $21\frac{1}{2}$ to 10, their relative strengths were as 11 to 25, so that the light cable, weighing scarcely one-half of the heavy one, had nearly two and a half times its relative strength.

The effect of compression and tension on the two constructions was then referred to, and it was maintained, that in this respect also, the light cable possessed advantages over the other.

In conclusion, the authors, while disclaiming any intention to find fault, expressed their strong conviction, that though the Atlantic cable was a step in the right direction, as compared with the heavier cables of former days, it yet fell far short, in mechanical structure and condition, of the light system recommended by Mr. Allan and others.

The practicability of safely submerging the present Atlantic cable was not denied, but it was strongly urged, that with a cable of its specific gravity, success would be greatly dependent upon the nature of the paying-out apparatus, and the sedulous attention of those in charge of the brakes.

It was considered advisable to postpone the discussion on this subject until the following Paper, which was announced to be taken at the next meeting, Tuesday, February 23rd, had been read—On the Practical Operations connected with the Paying-out and Repairing of Submarine Telegraph Cables, by Mr. F. C. Webb, Assoc. Inst. C.E.

February 23, 1858.

JOSEPH LOCKE, Esq., M.P., President, in the Chair.

THE paper read was ON THE PRACTICAL OPERATIONS CONNECTED WITH PAYING-OUT AND REPAIRING SUBMARINE TELEGRAPH CABLES, by Mr. F. C. Webb, Assoc. Inst. C.E.

The author explained, in the first place, that through the hesitation of those who had charge of the works in publishing facts which might affect the commercial value of such enterprises, he was unable to supply complete details of the operations performed in submerging those cables upon which he had not been practically employed.

He then enumerated and described, in general terms, the operations connected with the cables laid down from Dover to Calais in 1850 and 1851: that from Holyhead to Howth—that between Port Patrick and Donaghadee, and the cable to Ostend, relating at the same time the causes of the various failures to which some of them had been subject.

He then pointed out the route proposed for the Hague Cables, describing their construction, and the reasons which induced the engineer, Mr. Edwin Clark (M. Inst. C.E.), to determine on adopting the small single cable system. After alluding to the advantages and disadvantages of the simple over the compound cable, he expressed the opinion that this system was undoubtedly correct, but that the cables were made too light for this particular locality, and were not laid sufficiently far apart from each other. The arrangement adopted for testing the cable during the process of construction was then explained, and the serious error of submerging cables, in their final position, without having previously tested their perfection by suitable means, was noticed. The Atlantic cable was not tested under water, from the fear of its strength being impaired by the formation of rust. This might have been avoided by galvanizing, which was shown not to have the effect of weakening wire to the extent generally supposed.

The arrangements for coiling the cable on board the *Monarch* steamer for the Hague route were then detailed, and some remarks were made on the conditions of a coiled rope, showing the necessity of carrying the cable from the hold of the ship, when elliptical coils were used, over shears, fixed above the hatch-ways, to give the rope sufficient height to enable the twist, which the cable had received in coiling, to be neutralised: and also, the advantage of circular over elliptical coils, and the difference between a rope wound on a drum and that coiled up in itself. The manner of buoying or ranging off the course from England to Holland, the progress of the *Monarch*, and the manner of testing the cable during the period of paying out, were then narrated.

The act of speaking through a cable was not considered a sufficient test of its perfection. The case of the Atlantic cable was instanced, where, from Professor Morse's Report, the author concluded that a serious fault had passed unnoticed.

The aper then proceeded to remark upon the steering of vessels across tide-ways, for the purpose of paying out cables, as opposed to the manner of steering for an ordinary passage; showing the curve that would be taken by a cable, if an allowance was not made for the effect of tides. A practical method was given, by which the required rate and direction of the vessel across a tide could be quickly ascertained.

The operation of laying down the thick shore ends on the English and Dutch coasts was then detailed, as well as those of the Irish cables. The shore ends, similar to those of the Atlantic cable, tapered off from large sized wire to the same size as the cable.

In making arrangements for paying out a cable, the first point for consideration was the selection of a ship. The paper discussed the relative merits of screw and paddle-wheel steamers, giving the preference to the latter, except in the case of a screw where the engines were placed well aft, thus giving plenty of accommodation for stowing the cable. The next point for consideration was the disposition of the cable in the most convenient form for paying out freely. Accidents arising from improper coiling were quoted; and the necessity of careful coiling was dwelt upon. The great advantages of Mr. Newall's cone and rings for paying out were described.

The brake was the next consideration. The drum brake, of which an illustration was given, was that used on all cables hitherto successfully laid. Mr. C. Bright's brake was also mentioned, and its advantages and disadvantages were pointed out. Its chief disadvantages appeared to be its weight, or *vis inertiæ*, and the time required to release the pressure on the brake pulley. The importance of brakes in deep water operations, to regulate the speed at which the cable was being paid out, as compared with the rate of the ship on her course, and the necessity of providing for irregular strains, was adverted to. Mechanical contrivances to supersede manipulation in the quick release of the brake were disapproved.

The curve taken by the cable in descending great depths was discussed, showing it to be concave towards the ship, in every part, but approaching a straight line as it neared the ground. The angle which the cable made with the horizon when being paid out was about 9° or 10°; while the waste varied from 30 per cent. to 50 per cent.

The necessity of supplying buoys, with suitable moorings, to provide against accidents, was next urged. Several cases were cited where the use of buoys would have prevented the loss of cables and the consequent waste of property. The buoyage arrangements of the Atlantic cable were described.

The difficulty and danger of stopping the egress of the cable during the process of paying out were urged, and the means of providing against such accidents were represented.

The tendency of a cable astern a ship to swing it round in opposition to the action of the helm, with its effect in two or three instances, together with the means of avoiding such an event, by placing the free point of the cable as near the centre of the ship as practicable, were discussed.

Whilst proper allowance was given to the importance of possessing perfect machinery, the author was of opinion that sufficient value was not placed upon the necessity of having an organised and efficient staff. It was indispensable that those having the management of submerging cables should possess a nautical knowledge. The difficulty that would have been experienced in the late attempt to lay down the Atlantic cable, when the end had to be passed from the *Niagara* to the *Agamemnon*, was explained.

The paper then proceeded to describe various operations connected with the repairs of cables; showing, first, the means to be taken to detect the position and nature of the fault, and then those adopted to make the cable good; several operations of this nature, executed by the author in the North Sea, were described. Cables which had been broken by anchors, &c., were mended at points varying from two to fifty miles from land; at one time in a tug, at another time in a Dutch fishing boat; and, lastly, in the *Monarch* steamer, whose fittings for the purpose of general repairs were detailed. The operations of grappling, under-running, buoying, and picking up, were minutely described. In one instance 120 miles of cable were picked up, repaired on land, and relaid.

The paper concluded by pointing out that by such means cables could be regularly repaired, and that submarine wires, in shallow seas, became a much less precarious property than they were at first supposed to be.

ON A NEW CONSTRUCTION OF FURNACE, PARTICULARLY APPLICABLE WHERE INTENSE HEAT IS REQUIRED.

By Mr. C. WILLIAM SIEMENS, of London.*

THE high importance of the stores of combustible material which are distributed upon the surface of the earth renders their wasteful expenditure and rapid diminution in quantity in many parts a serious subject for consideration; and in the writer's opinion there is no object more worthy of the earnest attention of engineers and men of science generally than that of causing the generation and application of heat to be conducted upon scientific and economical principles. Our knowledge of the nature of heat has been greatly advanced of late years by the investigations of Mr. J. P. Joule, of Manchester, and others, which have enabled us to appreciate correctly the theoretical equivalent of mechanical effect or power for a given expenditure of heat. We are enabled by this new dynamic theory of heat to tell, for instance, that in working an engine of the most approved description we utilise at most only one-sixth to one-eighth part of the heat that is actually communicated to the boiler, allowing the remainder to be washed away by a flood of cold water in the condenser. If we investigate the operations of melting and heating metals, and, indeed, any operation where intense heat is required, we find that a still larger proportion of heat is lost, amounting, in some cases, to more than 90 per cent. of the total heat produced.

Impressed by these views the writer has for many years devoted much attention to carrying out some conceptions of his own for obtaining the proper equivalent of effect from heat: some of the results he has obtained are known to the members of the Institution, amongst which are the Regenerative Steam Engine and Condenser, the Regenerative Evaporator, and an apparatus for the economic production of ice. The regenerative principle appears to be of very great importance, and capable of almost universal application; and the object of the present paper is to describe an application of this principle to furnaces of every description.

The invention of the Regenerative Furnace is due to the writer's brother, Mr. Frederick Siemens; and it has been matured and variously applied by the writer within the last few months. The result has in all cases been a large saving in fuel over the plans in common use, amounting to from 70 to 80 per cent. of the total quantity of fuel hitherto consumed. The apparatus employed is moreover of a very simple and permanent description, and combines economy of fuel with other advantages, amongst which are the total prevention of smoke and a general improvement in the quality of the work produced.

Figs. 1 to 4 represent the new furnace in the form applicable to piling iron, or heating iron, steel, or other substances.

Fig. 1 is a longitudinal section of the furnace, and Fig. 2 a sectional plan; Figs. 3 and 4 are transverse sections.

The furnace consists of the heated chamber, A, and of two fireplaces or solid hearths, B and C, communicating respectively with the two regenerators, D and E. Each regenerator consists of a series of walls of firebrick, laid in open Flemish bond, in such a manner that the pigeon-holes of each wall are opposite the solid parts of the succeeding wall, the object being to form a number of zigzag or tortuous passages through the regenerators, leading to opposite sides of the valve, F, shown dotted in Fig. 1, at the bottom of the chimney, G. The valve, F, consists of a rectangular box of iron open at the two sides to the two regenerators, D and E, at the bottom to the atmosphere, and at the top to the chimney, G. A spindle passes through the centre of the two remaining close sides of the box, and carries a rectangular flap or moveable plate, fitting the box sideways, and bearing against one of its upper and one of its lower edges, according to the position of the tumbling lever and weight, H, which are fixed upon the spindle outside.

When the valve is in the position shown dotted in Fig. 1, the atmospheric air entering from below, proceeds in the direction indicated by the arrows, passing through the regenerator, D, over the fireplace, B, through the heated chamber, A, over the fireplace, C, through the regenerator, E, and by the valve, F, into the chimney, G.

A fire having been lighted upon the hearth, B, through the side opening, K, the flame passes through the furnace and through the regenerator, E, to the

---

* Paper read before the Institution of Mechanical Engineers.

chimney, G. In its passage through the regenerator, E, the first perforated wall that the flame strikes against will be heated to a considerable degree, the second wall to a lower degree, and so on in succession, the heat of the current being thoroughly exhausted by the time it reaches the chimney.

After about one hour's work the position of the valve, F, is reversed, and fuel is supplied through the opening, L, to the second fireplace, C, which is then acted upon by a current proceeding in the opposite direction to that indicated by the arrows. The cold atmospheric air comes in contact first with the least heated wall of the regenerator, E, and then with the more heated walls successively, acquiring thereby a degree of temperature approaching the temperature of the heated current which previously entered the same regenerator. The heat thus imparted to the fresh air greatly increases the temperature of the flame which is now being produced upon the hearth, C, and consequently the nearest end of the regenerator, D, will be heated also to an increased degree, the current reaching the chimney comparatively cool.

When the valve, F, is again reversed, the fresh air will be heated nearly to the increased temperature of the hot end of the regenerator, D, and will produce a still hotter flame with the fuel supplied to the hearth, B. It is evident that by a continuation of this process an accumulation of heat to any degree may be produced within the furnace, provided only the heat produced in combustion is greater than the heat lost by radiation and the heat absorbed by the metal or other substances in the heating chamber.

REGENERATIVE FURNACE.

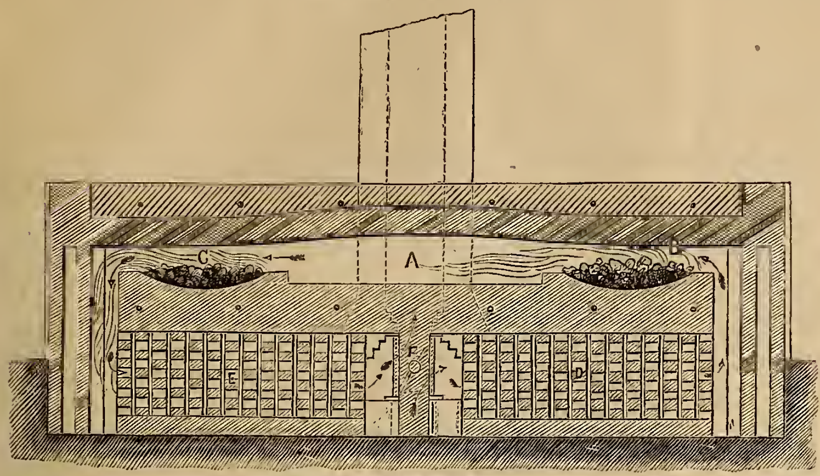


Fig 1.—Longitudinal Section.

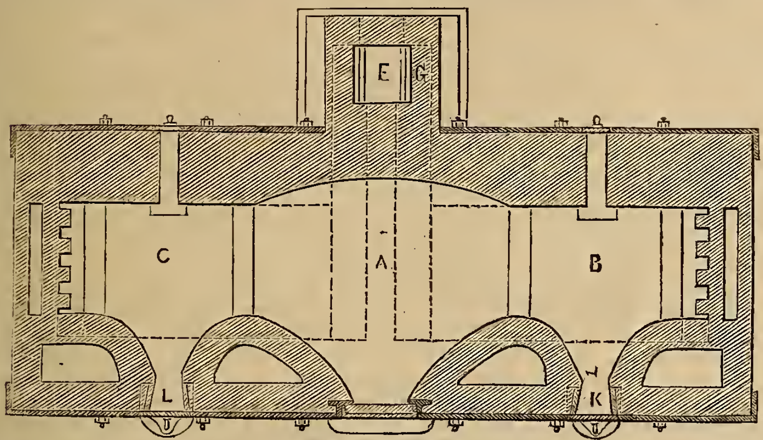


Fig. 2.—Sectional Plan.

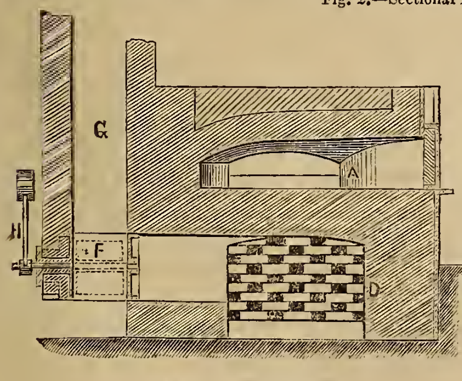


Fig. 3.—Transverse Section through Heated Chamber.

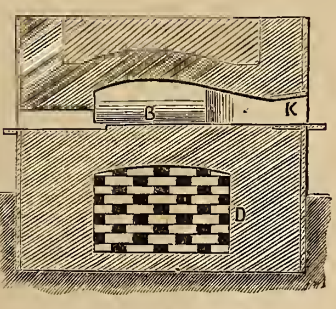


Fig. 4.—Transverse Section through Fireplace and Regenerator.

In the regenerative furnace now described, the temperature at which the heat is communicated to the materials does not affect the quantity of fuel requisite, except so far as increased radiation is concerned; for the products of combustion pass away in all cases at a temperature not above 200° or 300° Fahr. This new principle of furnace is therefore applicable with the greatest advantage in cases where intense heat is required. It has been applied to furnaces for reheating steel and iron, at the works of Messrs. Marriott and Atkinson, at Sheffield. One of these furnaces has now been in constant work for nearly three months; and according to a statement received from Mr. Atkinson it has worked quite satisfactorily, and the result of a careful comparison has shown a saving of 79 per cent. to be effected over the old furnace in heating the same quantity of metal. Mr. Atkinson has also applied this principle of furnace for melting cast steel, and has obtained a still larger saving, although the new melting furnace has not yet been rendered entirely satisfactory for the workman.

The regenerative furnace has also been applied to the purpose of puddling iron; and though the new puddling furnace has been completed and worked only for a few days at the works of Messrs. Rushton and Eckersley, at Bolton, the writer is able to state that it converts a charge of 480 lbs. of pig metal into wrought iron, with an expenditure of only 160 lbs. of common coal, as compared with 6 cwt. required in the ordinary furnaces: the net yield of wrought iron is higher than that of the ordinary puddling furnace, and the quality of the iron produced seems also to be superior. It is also worth mentioning that the chimney of this puddling furnace may be watched for hours, and no trace of smoke be seen issuing from it. Several other applications of this principle of furnace are contemplated by the writer, which it would be premature to enter upon on the present occasion.

INSTITUTION OF ENGINEERS IN SCOTLAND.*

Session 1857-58.

Professor. W. J. Macquorn Rankine, LL.D., F.R.SS. L. & E., President, in the Chair.

The first meeting of the session was held in the Philosophical Society's Hall, Andersonian Buildings, George Street, Glasgow, on Wednesday, 28th October, 1857.

The President delivered the following Introductory Address:—

On the Nature and Objects of the Institution.

Gentlemen,—We have had several general meetings already, but they were of a preliminary character, and this is the first meeting at which we are about to proceed to the transaction of our regular ordinary business—the reading of Papers, and the discussion of those subjects in which we are interested. Since this society was first formed, I am happy to see that many names of new members have been proposed, and many members who were not present at previous meetings are here now, and it is therefore desirable that I should make a short statement as to the nature and objects of this society, as distinguished from those of other scientific societies.

We may consider that the various societies of a scientific nature are divided into three classes. In the first class are those which are devoted specially to the advancement of science, and to the keeping of the members informed of the progress that science makes elsewhere. To this class the Royal Society belongs, the Geological Society, and many others. In the second class are societies intended for the popular diffusion of scientific knowledge, and the cultivation of a taste for science in those persons whose ordinary pursuits are not calculated to promote that knowledge, or to impart such a taste. Many societies combine the objects of those two classes, such as the British Association, and the Philosophical Society of Glasgow. In the third class is the society to which we belong: and the object of this class is the Improvement of Practice; and, combined with that, is another important object — that of keeping practical men informed of what is going on elsewhere in their art, and of the experiments made by others. And this is a most important object; for much time and money may be wasted, and much trouble be thrown away, by making experiments that have been made already; and an institution such as ours does much to prevent that evil. Now, this class of society is distinct from that whose object is specially the advancement of science; for, in that

* We have much pleasure in reprinting the inaugural address of Professor Macquorn Rankine before the Institution of Engineers in Scotland. We heartily wish the Institution success, and will report, from time to time, such parts of its proceedings as we may find space for in our columns.

class, the practical results are only regarded as experiments from which scientific conclusions may be drawn; they are used merely as the data for some scientific investigation: whereas, in our society, practical results are the main object. A society of this kind is different from those of the second class that I have mentioned, which tend towards making science popular; for we shall, to a great extent, have to consider details uninteresting or unintelligible to the general public. One of the objects of this society is, that its members shall discuss details with which they could not venture to take up the time of a mixed and popular meeting.

Having explained to you the nature of this Institution, I will state how it originated. Amongst previously existing institutions of the same class is the "Institution of Civil Engineers," which for many years has held its meetings in London, and the benefits arising from which are generally acknowledged; also the "Institution of Mechanical Engineers," having its chief place of meeting at Birmingham, and holding its meetings at other places besides, such as Manchester, Newcastle, and (last year for the first time) in Glasgow. I may also refer to the "Institution of Civil Engineers in Ireland," which is of recent date, but of great utility. I think I may trace the origin of the foundation of our present society to the effect of the meeting of the "Institution of Mechanical Engineers," held in Glasgow in the autumn of last year. Almost all the members here will recollect that meeting, which, for one of the kind, was almost unparalleled as to attendance, and excited immense interest among the practical men of this city. One thing remarkable about that meeting was the fact, that a large quantity of interesting and useful machinery was exhibited at it by Glasgow makers. Those proceedings very naturally produced the impression, that a society of engineers holding its meetings in Scotland, and in Glasgow as the chief seat of practical mechanics in Scotland, would be successful; and that idea having occurred to a few individuals, was gradually discussed by more and more, until it led, about six months ago, to the foundation of this Institution.

We are distinguished from the Institution of Civil Engineers, and from the Institution of Mechanical Engineers, by combining those two branches, as well as mining engineering, founding, and iron shipbuilding; and I think that combination is a most judicious measure. In former times, one could draw a line between civil engineering and mechanical engineering. There was a time when civil engineering was confined to works in stone, earth, and timber, and when the use of iron was restricted to the purposes of the mechanical engineer. But now, iron has become so important a material in the great works of civil engineering, that the two branches have been very much assimilated, and it is difficult to draw the line where one pursuit ends and the other begins; and the same may be said of various other branches of engineering. It is on this account that the Institution has included amongst its members, civil engineers, mechanical engineers, mining engineers, founders, and iron shipbuilders.

The object of this society is the advancement of engineering and practical mechanics, and the keeping of the members informed of what is being done elsewhere by other engineers, thereby enabling each one of our members to have the benefit of the experience of many. The advancement of engineering and practical mechanics comes from experimental knowledge. Experiments are of two kinds:—First, those which are made expressly for the purpose of testing the properties of some particular material, or ascertaining the laws governing some particular phenomenon, and which are intended for experiments and nothing more. Few men engaged in practical engineering have time enough at their disposal to carry on such experiments as these, and the leisure necessary for doing so is, for the most part, confined to a very limited number of persons. The second class of experiments comprises those which occur incidentally in the course of practice, and by which many important facts are brought to light, but which often pass unrecorded, and are, in that case, of no use to the great body of scientific and practical men. The observation of them may, indeed, be of use to the individual who observes them; but unless they are collected and recorded, the benefit to be derived from them is lost to the profession and to the public at large. One of the objects of this Institution is to collect and combine all those different experiments which occur incidentally in the course of the practical experience of engineers, and to deduce useful conclusions from them. With regard to the benefit of combining the experience of many practical men, an excellent remark was made by Mr. Scott Russell at the meeting of the "Mechanical Engineers," in Glasgow, last autumn. He said, that in a society of, say one hundred members, a member bringing the experience of one man, gets in exchange the experience of ninety-nine.

This is a most favourable time for the progress of such an institution as ours; and to show you clearly that such is the case, I may direct your attention to one or two facts in connection with the history of practical mechanics. In the early part of this century, the discoveries of Watt more especially, and also those of Smeaton and others, gave a great impulse to engineering and practical mechanics. Then Tredgold, Rennie, and Telford, and many more eminent engineers, made still further improvements in mechanics. That period of improvement, however, was followed by a time less favourable to sound progress in mechanics: a time which has happily now expired, for we are again advancing, and I shall tell you what appears to me to be the reason.

If I were required to state in one word what constitutes the characteristic advantage of skilful and scientific practice in the useful arts, I should say—ECONOMY. By economy, I do not mean parsimony, or the use of inadequate means towards an end; neither do I mean economy in money only; but economy of means of all sorts—economy of materials, of power, of time. The fact is, that perfect economy in any operation consists in accomplishing the end proposed by an amount of means just sufficient, without waste. For example, to construct a viaduct with just so much iron as is enough to support the required load safely, and no more; or (to go to machinery for an illustration) to drive a machine by just so much power as is necessary to do the work without waste:—that is economy:—to the attainment of it all our skill should be directed, and I am glad to find that such is being done every day. Some years ago, however, the case was different. There was then a period of wild speculation, which was most detrimental to the development of that kind of skill that leads to economy. For speculation and extravagance lead to the consequence, that where a structure is required to be strong, it is made so, not by skilful design, but by clumsy and costly massiveness; and that where a machine is required to perform much work, it is enabled to do so, not by economical use of power, but by its lavish expenditure. At a period of that sort, there is a tendency to neglect economy, and the inevitable result is the bringing about of a state of public opinion that discourages true skill in the useful arts. It leads to a prejudice in favour of structures and machines in proportion to their cost, irrespective of the results accomplished by them. At such a period, a line of railway will be regarded as a great undertaking, merely because it has cost a hundred thousand pounds per mile, and a bridge will be looked upon with admiration in proportion to the number of thousands of tons of superfluous material which it contains. The reaction after a period of extravagance tends to produce the opposite extreme—parsimony: the using of bad materials, and the attempting to effect ends by inadequate means. But I have very little to say about a reaction of that kind; for parsimony is a fault we very seldom fall into in this country: it is not in accordance with the British character. I think the period at which we have now arrived, is a period of PRUDENCE, when we have hit the right mean between economy and parsimony, and endeavour to produce all our results as effectively as possible, and without waste of any kind. In fact, we are now arrived at a time when there is every encouragement to form institutions like this, and to feel confidence that the result of our labours will be appreciated.

It has been the practice on the opening of societies of this description, to give a sketch of the previous history of the art or science with a view to the promotion of which the institution has been founded; but it seems to me that, instead of congratulating ourselves upon past progress, it would be better that we should look forward and see what further improvements are yet to be made; and, therefore, I will make a few remarks upon the various questions occurring to me on which knowledge is wanting, and to the elucidation of which our future labours may contribute.

I shall begin by a few observations with regard to the properties of materials. True economy and true skill require the best possible material; and the best material is that which is strongest in proportion to its weight; and that is the quality which makes iron the most useful and important of all materials. Iron is the most difficult of all materials to obtain pure. We can easily obtain the other ordinary metals in a pure state—gold, copper, silver, lead, tin, zinc; but the obtaining of pure iron, or iron even approaching to purity, is almost impossible. We know that there are immense varieties of qualities of that metal as regards strength, and that those variations of strength arise from impurities. One mode of obtaining good iron, is to bring it from the localities which produce it best—such as those where it is smelted with charcoal—Russia, Sweden, the British possessions in America; but the obtaining of it from these places is very expensive. Still, we know that in the weakest, as well as the strongest qualities, the iron itself is the same substance, and that its variations in strength arise from combination with other substances, such as carbon, manganese, sulphur, phosphorus, arsenic, silicon, calcium, &c.

The question then arises, "Can iron produced in our own country be so improved as to remove those foreign substances that lessen its strength?" Now, I have no doubt that a strong light may be thrown on that important question, by collecting the experience of the members of a society like this.

There are other materials besides iron that demand our attention—timber, for instance. A very important question may arise as to seasoning it, and preserving it from decay. For a long time it was thought that timber took years to season, and that the operation should take place in the open air; but we now find that it can be done in a few days by means of an oven. Of course that process, being in its infancy, can be improved. As to the preservation of timber, it is of consequence that we should collect the results of as much practical experience on this head as we can. The manufacture of artificial stone, and the strengthening of natural stone, and improvements in the manufacture of bricks, are also subjects of great importance.

As to the strength of materials, I scarcely need say that it has for a long time been a subject of inquiry; and much has been discovered in reference to it; but the discoveries themselves show how much yet remains to be discovered. I shall mention a few of the leading questions that have lately arisen on this subject. There is a very well-known rule for calculating the transverse strength of beams, founded on certain suppositions respecting the laws of the resistance which the particles of a bent beam oppose to the force which bends it. The rule is as follows:—Divide what is called the *moment of inertia* of the cross section of the beam by the leverage of the load, and by the greatest distance of any particle from the neutral axis; and multiply the quotient so obtained by a *constant multiplier*, depending on the nature of the material. Now, it has always been well known to scientific men, that the suppositions upon which that rule is founded are, in some respects, not exactly true; but it has been very generally taken for granted, that the error in the calculation is too small to be of importance in practice; and in order to obviate, in a measure, the defect that was apparent, different multipliers were used. Some recent experiments, by Mr. W. H. Barlow, have shown that no *constant multiplier* will give the strength. If we take several beams of similar figures, the same multiplier will answer; but as soon as we vary the form of the section of beam, we require a new multiplier for the same material; and Mr. Barlow has made considerable progress in determining what law the variations of the multiplier follow. But still, our knowledge of that subject is incomplete; and it yet remains to be discovered what is the exact and true law on which to found a rule for ascertaining the transverse strength of beams. As another example, I may refer to Mr. Fairbairn's experiments on the resistance of hollow cylinders against crushing, such as the flues of boilers. Mr. Fairbairn has found that by increasing the length of the cylinder the resistance is diminished; so that, within the limits of his experiments, the

strength is inversely as the length; but this must be only an approximate law; for, if it were exact, a tube, how thick soever, could be made so long that the slightest pressure would cause it to collapse: and we have yet to discover how the strength of a cylinder against outward pressure can be exactly computed. I have still another question to refer to with regard to the strength of materials; and it is one that has attracted much attention, having been discussed at great length at the late meeting of the "British Association" in Dublin. I refer to the stiffening of suspension bridges. This description of bridge is that which requires the smallest quantity of iron to support a given load; but an objection to its use on railways is its vibration, which would be so great, on the passing over of a train at high speed, as to be dangerous. It has been proposed to stiffen those bridges; and this has been done by means of lattice girders, that is to say, diagonal braces and horizontal bars along each side. It was formerly supposed that, to make a suspension bridge as stiff as a girder bridge, we should use lattice girders sufficiently strong to bear the load of themselves, and that, such being the case, there would be no use for the suspending chains. But Mr. P. W. Barlow, having made some experiments upon models, finds that very light girders, in comparison of what were supposed to be necessary, are quite sufficient to stiffen a suspension bridge; that, in fact, girders of a certain stiffness, attached to a suspension bridge, require, in order to produce a given deflection, twenty-five times the weight that would produce the same deflection if they were not connected with the suspension chains. And it turns out that, if mathematicians had directed their attention to the subject, they might have anticipated this result. It is true that Mr. Barlow's experiments were made upon models only; and it remains to be determined, on a large scale, whether a suspension bridge, with girders to stiffen it, is more economical than other forms of bridge, and whether we ought to use plate girders, half-lattice girders, lattice girders, bowstring girders, stiffened chains, or girders of some other form. That is a question about which there is much controversy, and which can only be settled by the collection and scientific discussion of the experience of practical men. The progress that has of late years been made in the crossing of large valleys by means of viaducts of moderate cost, has been very great indeed. Not long ago, it was considered very moderate if a viaduct could be constructed at the rate of 7s. per cubic yard of space covered; now the work can be done for 3s. 6d. or 4s. per cubic yard of space.

The construction of iron ships is a topic of importance to which I shall call your attention. There are very many questions remaining unsettled on this subject. Mr. Scott Russell pointed out, at the meeting of the British Association, the errors into which builders fall in constructing iron vessels on the same plan as they do wooden vessels, with keel, ribs, and planking, although the materials of the two do not at all resemble each other. But although this error is evident, no one likes to be the first to run the risk of constructing a ship, or anything else of such magnitude, upon a new principle: and it must be regarded as showing great courage on the part of Mr. Brunel and Mr. Scott Russell, that they have undertaken the building of so large a vessel as the *Great Eastern** on an entirely new plan, substituting cells for ribs, and dispensing with the keel. There is much yet to be discovered in the art of building iron ships; and in this locality, where iron shipbuilding is practised on so extensive a scale, we look forward to the exertions of this society for the collection of important results of experience.

With regard to boiler explosions, I think it is most important that, in all cases of such accidents, the exact facts should be minutely recorded; and that is one of the duties that should be performed by this society.

I shall now pass to the consideration of the means which we use for the purpose of performing work, and for effecting changes in the condition and form of materials. The agent we chiefly use for that purpose is heat; and the great agent for the production of heat is the combustion of coal; so that economy of fuel is, perhaps, the most important subject coming before any one studying practical mechanics. Numerous experiments are made upon this subject every day, by almost every person using a furnace; but the benefit of these experiments is lost to the profession for want of their being recorded. I would suggest, therefore, that a register should be kept of the consumption of fuel in the different furnaces of the city. The economy of fuel is a subject that, forty years ago, attracted the attention of the Rev. Dr. Robert Stirling, who invented an apparatus for saving heat, called the "regenerator," or "economiser." This apparatus is intended to be used when any fluid, whether liquid or gaseous, requires to have its temperature alternately raised and lowered. The fluid is passed alternately backwards and forwards through a grating or network of some solid conducting substance, which alternately takes away from the fluid and gives back to it a large proportion of the heat required to produce the alternate changes of temperature. Heat which would otherwise be wasted is thus stored up and saved, to be used over and over again. This apparatus, though employed to a limited extent, has never been brought into general use. But recently Mr. Siemens devised an application of the same principle to furnaces, which seems to have answered well; and it is to be hoped that the use of this principle may be farther developed. As another invention for the economy of fuel will be brought before you in a paper to be read this evening, it is unnecessary for me further to advert to the matter.

The subject of economy of fuel leads us naturally to the consideration of the steam-engine, and the economy of its power. All steam-engines now extensively used in practice are, in fact, Watt's engines, more or less developed and improved; and it appears that, in some instances, an economy has now been attained, such that the consumption of coal is from 2 lbs. to $2\frac{1}{2}$ lbs. per hour, per indicated horse-power. Theory shows that this is almost the greatest economy we can arrive at; and if we want to economise farther, we must introduce some new principle, such as the use of superheated steam, or heated air, which is analogous to superheated steam, inasmuch as it can be worked at a high temperature without attaining a dangerous pressure. The theory of this subject is now well understood; and the only difficulty that exists is as to its convenient practical application.

The use of electro-magnetic engines is also a subject for consideration; and to show that these are not mere matters of speculation, I may mention that they are actually used in France for driving small and delicate machinery, and are found to be well adapted for nice workmanship, where great power is not required, as they are clean, easily managed, and cool. But they are more expensive than steam-engines. To produce a given total amount of energy, the electro-magnetic engine consumes thirty-two pounds of zinc for every six pounds of coal that the steam-engine consumes; but, from the better economy of power of which the electro-magnetic engine is capable, it is possible that, for a given *useful effect*, the ratio of consumption may be one pound of zinc for one pound of coal, which would still leave a great excess of cost against the electro-magnetic engine. The subject is, however, well worthy of attention.

With regard to railways there are many questions yet to be decided; for instance, we do not at present possess a perfectly satisfactory permanent way, and we require much more experience before we shall possess it. The quality of rails used, too, is unsatisfactory, and requires improvement. Another want in railways is the means of going up inclines as steep as those on common roads, without the use of stationary or auxiliary engines, and that is a thing which, I have no doubt, can be attained by perseverance and careful study.

Improvements in canals are also proper for our consideration, such as the form of boats causing the least resistance, and also the best mode of traction along canals. At this late hour of the evening, I shall only mention docks, harbours, and sea-works in general; for the subject, if I went into it, would lead me to occupy your time too long.

The electric telegraph is also a subject in which mechanical engineers are concerned—at least, with reference to the machinery required for the submersion of submarine cables. It is evidently a problem, what is the best machinery for that purpose.

Then there is sanitary engineering—drainage, cleansing, ventilation, water supply, and the ventilation of mines. There is the arrangement for the production and supply of gas; and on this subject I may say, that it is desirable the matter should be studied with a view to discover some mode of diminishing the cost of gas.

The next subject upon which I shall touch is that of accurate workmanship, one of the most important means of promoting economy in machinery, for it is the means of diminishing friction, wear and tear, and breakage, and tends to economise power, money, and materials. It is simply by accurate workmanship that Mr. Whitworth has produced a rifle that will carry a ball accurately a mile. This leads to the question of improvements in tools, another most important matter, but so well appreciated in this great mechanical city, that I need not do more than mention it.

Another point of great interest is the reform of the present system of measures, especially those of length. The civil engineer uses the *mile* for measuring a long distance, the *chain* for a shorter distance, the *yard* for earth or rubble, the *foot* for ashlar masonry, timber, and the larger dimensions of iron structures: for scantlings of timber and iron, he uses the *inch*, which is also the unit of the mechanical engineer, and this is divided into eighths, sixteenths, and thirty-second parts. Now this complexity is most inconvenient, and should be reformed; but the difficulty is to get people to agree to a standard.

Legislation, too, as it affects engineering, is a subject of most important moment for our consideration. The patent law, although now greatly better than it was some years ago, still requires improvement, as regards both the law itself and its administration; and that is a topic that should be thoroughly discussed by an institution of engineers—of persons who both hold patents of their own, and use those of others, and who are therefore liable to be concerned very frequently with the patent law. Another kind of legislation to which an institution of engineers should turn its attention is that concerning the public safety. If any laws of the kind be provided, they should be such as shall not check the enterprise of engineers and mechanics, nor waste time, nor involve any greater restraint or inconvenience than is absolutely necessary. And in order that the Legislature may be fully informed of the facts that should guide them in framing laws on such matters, it is of the utmost importance that those subjects should be publicly discussed by such institutions as ours. I refer to this now, because I am sorry to observe a disposition on the part of some very eminent persons to recommend restrictions that I should think very injudicious. For instance, at a recent meeting at Birmingham, one of the most distinguished men in the world (Lord Brougham) suggested that the speed of railway trains should be limited to 25 or 30 miles an hour. Now, with proper care and good management, a speed of 70 miles an hour can be made as safe as one of 17. Accidents do not arise from the degree of speed, but from bad construction or mismanagement: and the putting of a restriction on the speed is not, therefore, the proper way to prevent them. Good workmanship and good management are what are required, and not a diminution of speed. To prevent a horse from running away we should not tie his legs, but put a good rider on his back.

Having thus far touched upon a few of the subjects which it will be our province to elucidate, I shall conclude. The matters I have brought under your notice are but a few of those which lie in the vast field that is before us. The locality in which our Institution is established is probably the very best we could have selected, and on this point I cannot help repeating to you the excellent observation that Sheriff Bell made at a public meeting last year. He remarked that Glasgow combined in itself the advantages of Manchester, Liverpool, Birmingham, and Newcastle, with some peculiar advantages of its own; that it had the manufactures of Manchester, the shipping of Liverpool, the hardware of Birmingham, and the coal of Newcastle, along with its own advantages. In fact, considering the vast extent and great perfection with which some branches of practical mechanics are here carried on, more especially in undertakings on a large scale, such as iron shipbuilding and steam-engine making, we may say that Glasgow is the Metropolis of Mecha-

* Since named the *Leviathan*.

nics. If an institution of engineers is to make good progress anywhere, it ought to be in Glasgow. I trust that, in this respect, my most favourable anticipations will be before long fulfilled, and that our Institution will prove of benefit to practice, to science, and to the country.

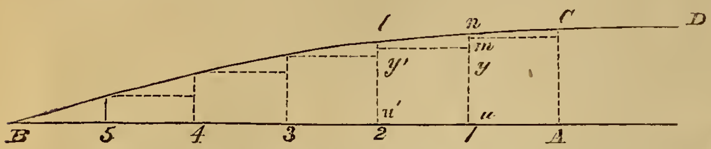
On the motion of Mr. Neil Robson, seconded by Mr. James Ferguson, a cordial vote of thanks was passed to the President for his address.

ON CALCULATING THE RESISTANCE OF STEAM-VESSELS.*

By Dr. Eckhardt, Privy Councillor, Darmstadt.

(Concluded from page 55.)

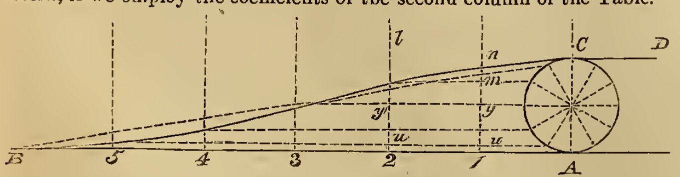
To simplify the demonstration of resistance of steam vessels, I had supposed, in the foregoing Paper, that the forebody and the afterbody are straight-lined prisms; but the construction in wood and in iron demands a curvilinear junction of these parts with the midship, whose flanks must be tangents of it. We shall now show why the resistance of a curvilinear prow and stern can be calculated by the given Table in the first chapter.



For this purpose, the axis A B must be divided in equal parts, A 1, A 2, which represent the abscisses, u, u^1, of the corresponding ordinates, y, y. By this construction we obtain the small prisms, l, m, n, &c., whose diagonals, l, n, can be regarded as straight lines, to which the given Table of resistance is applicable, if we put the rate $= \frac{y - y^1}{u^1 - u}$. The simplest combination would be a segment of a circle, B l C, touching the flank, C D, of the midship, whose radius is $r = \frac{AB^2 + AC^2}{2\,AC}$, and the ordinate of the segment $y = \sqrt{(r^2 - u^2)} - C$. In this formula the constant is given by $C = r - AC$. For $AB = 6$, and $AC = 1$, we find $r = 18{\cdot}5$, and the constant $C = 17{\cdot}5$. With these elements, we calculate the ordinates and the resistances of the single small prisms as follows:—

u.	y.	Rate.		Coefficient.	Resistance of the Prow.
0	1·00	0·00			
1	0·97	0·03	×	0·400	0·012
2	0·88	0·09	×	0·401	0·036
3	0·75	0·13	×	0·401	0·052
4	0·55	0·20	×	0·405	0·081
5	0·30	0·25	×	0·408	0·102
6	0·00	0·30	×	0·415	0·125
		Sum 1·00			Sum .... 0·408

The sum of the single resistances = 0·408 is the coefficient, with which the direct resistance of the midship must be multiplied, to obtain the moderation of resistance occasioned by the application of a circular prow. By a similar calculation, we find the propulsion of the curvilinear stern, if we employ the coefficients of the second column of the Table.



Another convenient curve for this purpose is the wave line, B l C, a species of cycloides, whose equation is $y = \frac{AD}{2}\left(1 + \cos.\frac{180}{n}u\right)$, in which n is the number of unities contained in the axis A B. If this axis is divided, for instance, in six parts, equal to A C = 1, the equation would be $y = \frac{1}{2}(1 + \cos. 30^\circ\, u)$. The resistance of the single prisms, l m n, will be found in the same manner as in the foregoing example.

u.	y.	Rate.		Coefficient.	Resistance of the Prow.
0	1·00				
1	0·93	0·07	×	0·400	0·028
2	0·75	0·18	×	0·403	0·073
3	0·50	0·25	×	0·408	0·102
4	0·25	0·25	×	0·408	0·102
5	0·07	0·18	×	0·403	0·073
6	0·00	0·07	×	0·400	0·028
		Sum..1·00			Sum...... 0·406

The rate of the straight-lined prism, A B C, by the same dimensions, will be $= \frac{1}{6} = 1{\cdot}66$, for which the Table gives the coefficient = 0·403; therefore, the resistances of these three combinations are:—

1. For the segment of circle .... = 0·408
2. For the wave line .... = 0·406
3. For the straight-lined prism .... = 0·403

The difference of them is not considerable; but the wave line seems to respond to the most conditions which practice demands.*

Dr. Eckhardt.

* By the publication of this little Treatise, it was only my purpose to complete in this peculiar case, the theory of *resistance*, as the base of a rational and scientifical determination of the *propelling power*, for which the experimental results of the *Leviathan* will give, I hope, the necessary elements.

* *Errata in Dr. Eckhardt's Article in our March Number.*

Page 52, right column—Line 39, *for* " or one square foot English," *read* " or by adding 30 per cent., and reducing for one square foot English," &c.

Page 53, left column—Line 1, *for* "adopting," *read* "adapting;" Line 17, the same correction.

Page 53, right column—Line 1, *for* "fraction," *read* "function."

CORRESPONDENCE.

MASS AND WEIGHT.

To the Editor of The Artizan.

Sir,—The different letters written upon *vis viva* to convince "G. J. Y." of the truth of this leading theorem in dynamics, contain all that could possibly be said about it, without entering into more extensive calculations. He who is not convinced by the reading of these, will not easily be so; I will not, therefore, enter further into the subject; I will only state what I know of the history of our often mentioned principle.

It appears for the first time in Huyghens' "Horologium Oscillatorium," printed in the year 1673. After this, Leibnitz and Daniel Bernoulli showed its truth to a larger extent; the latter calculating with it, for the first time, the movement of fluids in vases.

Lagrange, whose "Treatise upon Mechanics," printed in 1788, is to be considered as the basis of all the books which have since appeared on this science, treats "le principe de conservation des forces vives" as one of his chief doctrines, and praises Huyghens highly for the great benefit which science has derived from his discovery. After this time, the same principle has continued to be greatly used in all purely scientific calculations in theoretical mechanics. But with the development of engineering in our century, men of science applied it with great success in calculations for machinery, as Poncelet, in France, Redtenbacher and Weissbach, in Germany.

I am acquainted only with French and German books, viz., Lagrange's "Mecanique Analytique," Duhamel's "Mecanique Analytique," Redtenbacher's "Principien des Maschinenbaues," &c. However, I accept "G. J. Y.'s" advice to read and study, as this is in all cases a good thing. No book could, however, change my opinion of *vis viva*, and reading a mathematical dictionary is not the right way to get on in this science.

Not only the *vis viva*, but also the term *mass*, and its application in my first letter, gave occasion for some rather unpleasant remarks on the part of "G. J. Y.," and I must now try to explain myself.

The best plan is to give no definition of mass, as Duhamel:—"We give no definition of mass, as this is as useless as a definition of time or space." His example, however, has been followed by few authors, and endeavours to give a truthful definition are to be found in many books. If it be necessary to adopt one, I should prefer the definition which has been given by Redtenbacher—the German Poncelet—according to which I called mass a "principle." A mass cannot begin to move when it is at rest, and it cannot change its velocity without the influence of a force. This quality of mass is its characteristic, and the definition alluded to says:—"The mass of a body is the quantity of that which has this quality." I am sorry to say that I could not find the English words which would serve as a proper translation of the German; being, therefore, unable to give you my definition, I state this to explain why I called mass a passive principle.

However, "G. J. Y.'s" definition: that mass is the quantity of material, may be accepted, especially as it is easily evident to a person fond of definitions. Suppose it to be correct, the consequence that mass and weight are one and the same, is still an absurdity. If the mass of a body is the quantity of material, then it must remain constant, as long as the body is not altered. Therefore the transport from the pole of our globe to the equator can not change the mass of any body. Still it is a fact, that a piece of iron which would weigh 200 lbs. at the north pole, weighs only 199½ lbs. here, and 199 lbs. on the equator, without even the most minute loss of material, so that the mass is the same. We should find the weight of the same piece of iron on the surface of the sun to be 5,900lbs., and we shall be able to note a decrease in weight in bringing it to the top of a high mountain. The mass is always *proportionate* to the weight, and nowhere neither "equal" nor "identical."

The accelaration, g, and the weight, P, change at the same time; and as P is a force, g, the velocity produced by this force, P and g are undoubtedly proportionate. In terms: $P = A\,g$, or $A = \frac{P}{g}$.

A is a constant number; it is proportionate to P, and, at the same time, independent of the changes which P has to undergo. These are the very same qualifications which we made for mass, and A will serve us in any way for its measure. I say now, 2 M = A, and others say, M = A; hence, the two different expressions, $M = \frac{P}{2g}$, and $M = \frac{P}{g}$. I call the mass of a body 1, which body has here the weight of 64 lbs.; others call the mass of a body 1, which body has here the weight of 32 lbs.; and if we find it convenient to call the mass 1 which weighs 100 lbs. or 200 lbs., &c., we can do so. We have liberty to choose unities, and a confusion can never arise if we bear in mind how we choose them.

Besides, we transfer mass into weight, as this is *handier* for any calculation in numbers, and by both ways we get exactly the same results.

All this is far from being a rigorous demonstration of the relations existing between force, mass, velocity, and time, which could not be given in a few lines. I want only to prove that even *common sense* must allow that the difference between mass and weight is not a mere "hallucination as to the meaning of words."

If mass and weight were identical, then bodies which have no weight could have no mass.

The hypothesis that an elastic and enormously thin fluid, called æther, is not only contained in the interior of everything on this planet, but that it fills up also the whole endless space, agrees so well with all experiments and discoveries in natural philosophy, and serves so strictly to explain all phenomena of light, that it is generally adopted by men of science. It is proved, with a certainty which scarcely admits of any doubt, that the appearance of light is nothing else than oscillations of this æther, which are caused by the illuminating object, and produce the sight in reaching the retina of our eye. Huyghens, Descartes, Euler, Thomas Young, Fresnel, Fraunhofer, and Cauchy, and nearly all natural philosophers of our days, are of this opinion. All say that each particle of æther has a mass; and if they would allow the æther to be of the least weight, the whole theory would immediately collapse.

It is very probable, but not yet proved, as in the case of light, that heat is a mere consequence of this æther, perhaps of another kind of oscillation performed by it. If this be the case, as I suppose it to be, then the collision of masses, *being as unelastic as possible, would still produce small vibrations* in the interior of both. If heat is movement, then it is easy to explain how a collision is able to produce heat, and how a unit of heat can be converted into 772 foot lbs. in applying to both cases the principle of *vis viva*. After all, I suppose that "G. J. Y." himself believes in the truth of the *vis viva* theory, and that he only makes every imaginable objection so as to get quite sure of it in reading the letters of his opponents.

It is at least impossible for me to understand how a man who professes to be acquainted with literature can deny something in which, although it be not evident to him, the highest geniuses, I dare say all men connected with this science, for more than a hundred years, have believed, and that he can be bold enough to say—you *all* are wrong, *I alone* am right.

I am, Sir, your obedient servant,

Greenock, Jan. 23, 1858. ARTHUR LÖWENTHAL.

ON CALCULATING THE RESISTANCE OF STEAM-VESSELS.

To the Editor of The Artizan.

SIR,—The experiments of the French academicians have been several times referred to by me; and it is gratifying to find that Dr. Eckhardt (who, it appears, has made himself intimately acquainted with the records of those experiments) concurs in my high estimate of their value. It might seem captious and invidious in me if I were to state all the objections to which I conceive his elaborate paper to be liable. Two important mistakes, however, it is necessary to notice:—1st. For the purpose of vindicating English experiment and analysis; 2nd. For the vindication of my own carefully drawn deductions from the experiments of both England and France. I may observe, *en passant*, that it is pleasing to see your columns occupied by communications from the banks of the Thames, the Clyde, and the Rhine on the same subject.

Dr. Eckhardt describes Beaufoy's experiments as "the experiments of Colonel Beaufoy *made with thin plates*," and he subsequently states, "it is evident that by these disquisitious the breadth of the base must be regarded as constant, and only the angle on the top of the prism variable—a consideration which was observed by the French experiments, *but neglected by the analysts and the English experiments*." The words I have italicised merely evince that Dr. Eckhardt has a pleasure in reserve: when he makes himself acquainted with British experiments and British analytical investigations he will, I am sure, be ready to confess his mistake. In Beaufoy's large work he may find an abundance of what he desiderates, and, besides, materials for the employment of his skill in mathematical analysis, of much greater importance than anything which he has at present produced. If he will consult Dr. Robison's writings (many others might be named) he will see that the subject has not only been analysed, but almost exhausted.

And now with reference to "G. J. Y." The moment I saw the table which terminates the first section of Dr. Eckhardt's article, I exclaimed, "Either I have been in a state of hallucination, or our learned friend has, from some inadvertence, slipped into serious error." I may here be permitted to say that I have undeviatingly felt it to be my duty, in consideration for the character of THE ARTIZAN, to take the utmost care that no statement of facts made by me could be justly impugned, and no calculation of mine should require correction.

In your Number for June last, p. 137, you published for me a calculation of the resistance encountered by a surface of a foot square, at a velocity of 3 miles per hour, as follows:—

"$\frac{5280 \times 3}{60 \times 60} = 4{\cdot}4$ ft. = space passed through in a second. Using the well known formula $\frac{V^2}{2g}$ we have $\frac{4{\cdot}4 \text{ ft.}^2}{2 \times 32\frac{1}{6}} = {\cdot}3$ ft. and $62\frac{1}{2}$ lbs. × ·3 = $18^{\cdot 75}$ lbs., say, for practical purposes, 20 lbs."

Now Dr. Eckhardt has in his table for the resistance at a velocity of 3 miles per hour, 33·21 lbs.! This is a discrepancy which is startling, and which requires investigation. His table is intended for reference—he so uses it in the case of the *Leviathan*—and therefore its correctness is a matter of the highest importance.

The formula $\frac{V^2}{2g}$ he has $\frac{V^2}{4g}$; but they are both of the same value. In England we *now* put the symbol g to represent the velocity of a falling body at the end of the first second of time; on the continent they frequently use the same symbol to represent the space fallen through in that period: and we formerly did the same. Thus $\frac{V^2}{2g} = \frac{V^2}{2 \times 32\frac{1}{6}}$ and $\frac{V^2}{4g} = \frac{V^2}{4 \times 16\frac{1}{12}}$, and are both of exactly the same value.

I observe that Dr. E. has the resistance of sea water, while I have the resistance of fresh; this would make some difference. Assuming an English cubic foot of fresh water to weigh 1,000 oz., a cubic foot of sea water at the same temperature would weigh at most 1,030 oz.; and, consequently, the density and resistance would be in the ratio of 1000 : 1030—that is, if the resistance be 20 lbs. in fresh water, it would be 20·6 lbs. in the water of the sea. But 20·6 lbs. is nothing like 33·21 lbs. Where, then, is the mistake? To me it seems as natural to assign 20 lbs. to a square foot as its resistance, when moving at 3 miles per hour, as it does to give twenty shillings as change for a sovereign. By-the-by, another cause appears for the difference. Dr. E.'s mile is not our mile of 5,280 ft., but $\frac{1}{60}°$, which is equal to 6,078 English ft. (the statute miles in a degree being 69·07). The 2 miles are then in the ratio of 1 : 1·15, and $1^2 : 1{\cdot}15^2$: : 20·6 lbs. : 27·24 lbs.; so that the square foot, at a velocity of 3 geographical miles per hour in *sea water*, would have a resistance of 27·44 lbs. This does not tally with the 33·21 lbs. of the table.

I am compelled, after this, to distrust the Doctor's figures. Upon examining them, I find them to be correct down to the following (Sect. 1, p. 52):—

"Therefore, for *one* square foot = 2·91 lbs. French measure and weight.
for *one* square foot (English) = 3·58 lbs.
and sea water = 3·69 lbs."

Here is manifestly the mistake. An English square foot is *smaller* than the French square foot, according to Dr. E.'s foot note, which is nearly correct, in the proportion of 1 to 1·14. It would, therefore, encounter a *less* resistance—say 1·14 : 1 : : 2·91 lbs. : 2·55 lbs. Instead of 3·58 lbs. we should have 2·55 lbs.! But if English lbs., as well as an English square foot be intended, the 2·55 lbs. would be increased, because the English lb. is lighter than the old *poid de marc*. Taking, according to Dr. E.'s foot note, "1 *poid de marc* = 1·08 lbs. avoirdupois," then 1 : 1·08 : : 2·55 lbs. : 2·75 lbs.; and if we increase this for sea water, we have 1000 : 1030 : : 2·75 lbs. : 2·83 lbs. Thus the resistance in lbs. in the Table for 1 mile, or $\frac{1}{60}°$, should be 2·83 lbs., instead of 3·69 lbs. This is a very large error, vitiating the whole table to the extent of 30 per cent.!

The mistake is in using 2·91 × 1·14 × 1·08 = 3·58, instead of $\frac{2{\cdot}91 \times 1{\cdot}08}{1{\cdot}14} = 2{\cdot}75$.

We can now check my former calculation. I showed that the resistance to a foot square, urged through *fresh* water at the rate of 3 *statute* miles per hour, or 4·4 ft. per second, was 18·75 lbs., and I put, to facilitate calculation, 20 lbs. The above 2·83 lbs. is the resistance at 1 *geographical* mile per hour in sea water; and 2·83 lbs. × 3^2 = 25·47 lbs. would be the resistance at a velocity of 3 geographical miles. We have seen that the 2 miles are to each other as 1 to 1·15; therefore, $1{\cdot}15^2 : 1^2$: : 25·47 lbs. : 19·26 lbs. = resistance at 3 statute miles per hour in sea water; and 1030 : 1000 : : 19·26 lbs. : 18·7 lbs. = resistance at that velocity in fresh water. This is almost exactly what I stated.

The other calculations, and the utility of considering a parallelopiped "mounted" with a wedge at each end as an approximate type of a steamship, may form subjects for future investigation.

G. J. Y.

THE "LEVIATHAN."

To the Editor of The Artizan.

SIR,—The *Leviathan* seems destined to effect the wreck of formulæ. Mr. Moy reckons that "she will go 16 miles an hour with her paddle engines only, and with her full power 25 miles per hour!" The four paddle-wheel engines are expected, I believe, to work up to 5,000 H.P., and the total actual engine-power of the ship to reach about 12,000 H.P. Dr. Eckhardt calculates that when the ship is immersed to a draft of 30 ft. she will be propelled at 16 miles (or knots) per hour by 996 H.P.! Mr. Atherton publishes a Table, putting her highest velocity at 15·76 knots per hour with 12,000 I.H.P.! And, if I do not mistake Admiral Moorsom's mode of calculation, as developed in Table B at the end of his admirable little pamphlet, it would give the velocity 27 ft. per second, or 16 knots per hour at 20 ft. draft of water, with an *actual* power amounting to about 9,000 H.P. It is highly desirable that Admiral Moorsom should amplify his remarks upon the subject, and give them extended publicity. It appears to me that the *basis* of his calculations is a valid one, and he clearly recognises the great want which exists of accurately-reported experiments, made in actual sea service with the aid of dynamometers, and such appliances as scientific men would suggest. The mathematician would then have proper materials for his analysis.

One feels that the discordance exhibited above is discreditable to us. I have also ventured to make a calculation of the probable speed of the ship, taking for my guide the lines so admirably delineated in your Number for December, 1856, and my calculations induce me to guess (really my process, although a laborious one, has been so empirical that it is, after all, but little better than guessing) that on the trial trip we may fairly expect a speed of 19 or 20 miles per hour, and that an average speed at sea of 16 or 17 knots per hour may be anticipated without much danger of disappointment, until her bottom becomes foul, and her speed thereby retarded by the increased friction.

Mr. Atherton adheres to his exploded formula $\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} = C$; and his Table is at once a demonstration of his fidelity, and the absurdity of his formula.

He has—

H.P.	Displacement. Tons.	Draft. Ft.	Speed. Knots.
1,000	17,000	20	6.88
1,000	28,000	30	6·16

At 20 ft. draft of water the average area of transverse sections would be 875 ft.; the area of the midship section, 1,400 ft. At 30 ft. draft of water the average area of transverse sections would be 1,441 ft., and the midship section 2,220 ft.; the average width between the 20 ft. and 30 ft. drafts, in midships, being 82 ft. The resistance to a plane of 875 ft. at 6·88 knots per hour, would be about 117,740 lbs. to a plane of 1,441 ft.; at 6·16 knots per hour, would be about 155,858 lbs. I do not hold out the average transverse section as the absolute measure of resistance,—it is modified by length and form; but I do offer the suggestion as sufficient to show that Mr. Atherton's formula has misled him. G. J. Y.

STEAM SHIP CAPABILITY.

To the Editor of The Artizan.

Sir,—In The Artizan for this month (No. CLXXXII.), it appears that your correspondent, Dr. Eckhardt, in his excellent article, "On calculating the Resistance of Steam Vessels," comes to the conclusion (page 54) that 996 H.P. may be expected to propel the *Leviathan*, loaded to her 30 ft. draft, at the speed of 16 miles (I presume statute miles), or 13·88 nautical miles per hour; but, as by my article, "Steam Ship Capability," page 66, in the same Number of The Artizan, it appears by my table that to attain the speed of 13·70 nautical miles per hour, the *Leviathan*, at 30 ft. draft, will probably require no less than 11,000 indicated H.P., may I request the favour of your communicating to your readers what is the measure or definition of the unit of power (H.P.) by which Dr. Eckhardt calculates that 996 H.P. may be expected to produce the same result? I need scarcely observe, that by the unit indicated H.P. referred to by me, a power equivalent to 33,000 lbs. raised 1 ft. high in one minute of time, measured as usual by aid of the steam indicator, is designated.

I am, Sir, your very obedient servant,
Woolwich Dockyard, 5th March, 1858. Chas. Atherton.

VIS VIVA.

To the Editor of The Artizan.

Sir,—"G. J. Y.'s" paper, in the February Artizan, to a person without an idea on the subject, and of confiding temperament, *might* appear to bear some resemblance to a reply to the one by me in the January number: as *he* would say, *nous verrons.*

To my statement—*vis viva* is not force—"G. J. Y." objects: since *vis* means force, this is tantamount to saying "force is not force." In reply, this appears to be tantamount to being of opinion that, in a scientific argument, an opponent may be answered by any misrepresentation; in the present instance, by the omission of a qualifying word, which entirely alters the signification of the term to which it is attached. My statement, fairly translated, was *living* force is not force; the distinction I endeavoured to explain; and, as clear notions on this subject strike at the root of fallacious speculations, this may be briefly recapitulated as follows:—

Vis viva is a conventional name applied to the effect of force upon mass, free to move under the action of the said force; it is measured by twice the quantity of work which that mass can perform before it can be brought to rest, and is strictly equal to the product of the mass by the square of its velocity.

In Smeaton's language, it is called "power," or "mechanic power;" and the "mechanical effect" of a given power is precisely what is understood by the later introduced term "work done."

In Professor Moseley's language, it is the "accumulated work" of the moving mass; that is to say, the work which has been expended upon the mass in communicating its velocity, and which it must again give out before it can be brought to rest.

When we perform work, we overcome a resisting force through some definite space, and the work is measured by the product of the force and space, the unit being one foot-pound; that is to say, a resisting force of one pound overcome through one foot of space, or any other relations of force and space which yield unity as product: hence the deduction, *vis viva* is not *force*; for, with the first a foot-pound is the unit, whereas, in the comparison of force, a pound is the unit. "G. J. Y.," to some extent, manages to see the distinction, since, in one part, we find him noticing that my "pounds are not ordinary pounds but foot-pounds."

I had offered some explanations on an important and not generally known dynamical question, which "G. J. Y." finds to be very *recherché*, but bearing very remotely upon the cube theory: I presume for the reason that they bore very directly on him; whereas, after having ornamented the discussion with Greek comedy, Kilkenny cats, &c., he had referred that theory to a sententious acquaintance at "Carisbrooke!" He ought to have left the matter entirely to his referee, for his attempt at another reply has only furnished another set of illustrations of his natural or acquired talent for the confusion of plain statements.

At page 19, I state: "For every 772 units of the product, the weight of water in lbs. into its vertical descent in feet, one unit of heat now exists in the water which did not exist formerly;" and a unit being that quantity which raises the temperature of 1 lb. of water by one degree, it follows, that if 1 lb. of water fell 772 ft. and lost all velocity of descent, its temperature would be elevated one degree; and if it fell only 333 ft., and did not lose all velocity of descent, then its temperature would be elevated by less than $\frac{333}{772}$, or less than 4-10ths of a degree. Should millions of lbs. of water fall under the same circumstances (the case at the Falls of Niagara, as adverted to by "G. J. Y."), then at the lower level we should have the temperature of each particular lb. elevated by less than 4-10ths of a degree. But, from my statement, "G. J. Y." deduces "that it ought to be as hot as an oven." Might I suggest that in such a heated oven "Gog and Magog's" wooden heads might be put to a purpose neither "useless" nor "ridiculous," and that, "in the vicinity of so much heat," "G. J. Y.'s" might be profitably employed in a *cool* revision of the elements of arithmetic.

From his word or two on what he calls my formula, it now appears that, in his first reply, he has contrived to introduce nearly a column of scurrility in answer to a statement which, viewed through the medium of his intelligence and figures, amounted to this: the number which multiplies 42,000 lbs. to reduce it to 6,000, or 3,000, is a small fraction; and the objection now is, that he is unable to comprehend whether said small fraction is constant or variable. Now he has repeatedly quoted my statement that it depends on the form of the ends; and he appears to be aware that vessels are built of various forms, "some bluff and some sharp." I cannot but hope that he will come to see the obvious inference; but, in the mean time, I think he should direct his attention to the more elementary important question of the distinction between mechanical effect (or work) and force.

"G. J. Y." contemplated that increasing the velocity of a plane drawn through water by a falling weight was the same thing as increasing the velocity of a raised weight by the like means,—first assuming, and then asserting, that in both cases the motion is uniformly accelerated. I have twice advanced arguments showing that in the case of the plane this supposition is absurd; to which he now feigns to reply by quoting two statements of experimental facts: "the motion became perfectly uniform after a very little way," and "the weight went on falling at an accelerated velocity for about fifty-six seconds, and then the velocity became constant." Notice, that in neither case is uniformly accelerated velocity hinted at. Who doubts that motion took place with an accelerated velocity, and that after a short time it became uniform! "G. J. Y." states that by the laws of dynamics the increments of velocity must be uniform, in which, as is usual, he is entirely mistaken. In any very small times, each equal to t, the increment of velocity is given by the expression $\left(g - \frac{C V^2}{W}\right) t$, where g is the accelerating force of gravity; C, a constant involving the area of the plane; V, the velocity at the assumed instant; and W, the descending weight: in words, it is as the accelerating force of gravity diminished by a quantity proportional to the square of the velocity, and inversely as the descending weight; hence it diminishes rapidly with increase of velocity, and when, $\frac{C V^2}{W} = g$, vanishes altogether, and the motion continues uniform. But on "G. J. Y's" supposition, the increment continues definite and uniform until a certain velocity is attained, and then instantaneously abolishes itself. Notice that, in vanishing, the increment of velocity cannot pass through the intermediate values between a definite value and nothing, or "G. J. Y.'s" uniformity would be ruined. I should like to know by what law this sudden lapse from something to nothing is sanctioned: "G. J. Y." may indisputably claim it as his own.

But he now contemplates that "a 20 lb. weight falling with a constant velocity, drawing a floating body through the water at 10 ft. per second, must have the resistance of that body *reduced* to draw it at 20 ft. per second: and that a weight of 80 lbs. falling at 20 ft. per second, will draw a body through the water which has four times the resistance of the latter, but not of the former." So far, our agreement is complete; for these contemplations may be shown to be quite in accordance with the "cube" theory.

"G. J. Y." does not state the velocity of descent of the weight, in the first proposition, nor the velocity of the plane in the second, representing them generally by V and v respectively, and by C and c, denoting two terms involving the mid area of the body in the first proposition. The algebraical statement, according to the principle that the work done by gravity on the constant falling weight is equal to the work expended on the resistance, is as follows:—

If $20 \times V = C\,(10)^2 \times 10$,
And $20 \times V = c\,(20)^2 \times 20$;
Then, obviously, $C = 8\,c$;
Also, $C\,(10)^2$ being the resistance in the first case,
And $c\,(20)^2$ the like resistance in the second,
Substituting, in this, for c its above derived value,
It becomes $\frac{C}{2}\,(10)^2$, which, very obviously, is less than $C\,(10)^2$,
And is "G. J. Y.'s" cogitation, No. 1, put definitely.

His second proposition is:—

If $80 \times 20 = 4 \times \frac{C}{2}\,(10)^2 \times v$,

Then, as obviously,

80×20 can not be equal to $4 \times C\,(10)^2 \times v$ —

Cogitation, No. 2, similarly stated.

But he goes on :—"In other words, the quicker the weight falls constantly, the less work it does on the resisting body per foot. This truth I have shown to be incompatible with the cube theory." Now, I have shown "G. J. Y.'s" statements to be quite in conformity with the cube theory; therefore, they and the deduction which he declares to be incompatible with that theory, must, consequently, be mutually inconsistent; hence, said deduction, rests merely on his authority: the assertion of its truth I meet with the most pointed denial, and a declaration that it is opposed to the basis of all mechanics. I defy "G. J. Y." to produce either fact or tenable argument in opposition to the principle that *forces produce their full effects in the direction of their action, whatever be the velocity of the body on which they act;* which may be otherwise stated as the principle which recognises the *absolutely definite and indestructible nature of mechanical effect*, and which, in its utmost generality, extends to whatever transmutations mechanical effect may appear to undergo, whatever be the names by which these transmutations be known.

Dr. Whewell, in his recent edition of "History of the Inductive Sciences," remarking on mathematical deductions from known principles, observes:—"Such deductions become much more easy and more luminous by the establishment of general terms and general propositions suited to their special conditions;" and the foregoing principle will be found entirely implied in the statement offered in the preceding volume of The Artizan, page 235, viz.:—*In any system of moving bodies, and during any interval of time, the difference between the work done by the working pressures, and the work done in overcoming resistances to motion, is equal to half the variation of* vis viva *of the system, during the given interval.* In this, "G. J. Y.," at page 261, admits "no doubt there is latent truth:" curiously enough, after having "disposed" of *vis viva*, and, in transcribing, disposed of the sense, by altering the phrase "the difference between the work done *by* the working pressures" into "the difference between the work done *and* the working pressures." Now, work being measured in *foot*-lbs., and working pressure in lbs., the difference between the work done *and* the working pressures resembles, for example, the difference between square yards and lineal yards in this respect—that they are both differences of quantities of unlike dimensions, and possess the singular property that it is only up to a *certain* point in his studies that the *mathematician* could form any notion of them; ever after they defy either comprehension or analysis.

It is in introducing a popular statement of the above-mentioned principle that Dr. Whewell makes the remarks I have quoted. He subsequently states: "This is not a new principle, being in fact mathematically equivalent to the *conservation* of *vis viva*." But what the Master of Trinity declares to be luminous "G. J. Y." confidently asserts to be a "fool's light!" I hope the latter gentleman will in future be more guarded in the use of epithets, which quite possibly may be shown to be very suggestive of qualifying terms for his opinions.

"G. J. Y." approves of Smeaton's statement, that raising a weight in a given time is a proper measure of power: does he equally accept the connected clause of that statement?—"the product of the weight by the height to which it can be raised in a given time is the measure of the power raising it;" and Smeaton's reservation: "But *note*, all this is to be understood in case of slow or equable motion of the body raised; for in quick, accelerated, or retarded motion, the *vis inertiæ* of the matter moved will make a variation."

In the above statement, an amount of power involved in the variations of velocity of the matter moved is pointedly indicated, though not included in the statement; and it is precisely this power which is the subject of my statement of the principle of *vis viva* in its simplest form, and in which, conversely to the former, no cognisance is taken of power expended in the manner implied in Smeaton's statement. Now, "G. J. Y." manages to confuse the one with the other, and, of course, finds them to "jar irreconcileably," since there is no necessary connection between them; but Smeaton and *vis viva* are quite reconciled in the principle with the "latent truth in it," which includes both, as "G. J. Y." will find, if, previous to trying to *improve*, he endeavour to understand it.

"G. J. Y." having never heard of the mass of a particle before, I referred him to an author whom he pretended to quote; but he still asserts that "mass of a particle is a solecism" originating in my ingenuity. That your readers may appreciate the *ingenuity* of his statements, I refer to that work (Earnshaw's Dynamics), paragraph 154:—Let m_1, m_2, m_3, be the *masses of the particles* of which a body is composed, M the whole mass.......... then $\Sigma\, m = M$;" in words, the sum of the *masses of the particles* equals the whole mass, the symbol m representing, not "mass in the abstract, but *mass of a particle* in the abstract, occurring in the work not once or twice, but hundreds of times; also at the end of the same paragraph, we have, "Definition. The *vis viva* of a particle is the product of its *mass* into the square of its velocity"! I again repeat that in my copy (second edition, 1839), an alleged quotation advanced by "G. J. Y." does not occur, and that Earnshaw's statements indicate his opinion to be directly opposed to that imputed to him by "G. J. Y."

In concluding, we are presented with a quotation from M. Comte, which, we are informed, "conveys a salutary hint;" it must be as to what "G. J. Y." meant by "merging physico-mathematics into metaphysics;" for who could see anything salutary in the position that the concurrent testimony of the highest authorities on a mathematical subject, is to be even *put in comparison* with the opinion of any metaphysician, however distinguished as such. My opinion is, that M. Comte's statement is very questionable, both in point of philosophy and fact; but for an obvious reason, I reserve its examination for some other opportunity.

Govan, Glasgow, March 13th, 1858. Robert Mansel.

THE RESISTANCE OF STEAM-VESSELS.

To the Editor of The Artizan.

Sir,—Your March Number contains the first part of a Paper by Dr. Eckhardt, "On Calculating the Resistance of Steam-vessels," in the commencement of which that gentleman expresses surprise at the differences of opinion among those who have engaged in the discussion of that question. From those opinions, he could scarcely fail to observe that the writers might be divided into two classes: the larger, named by the other the "cube theorists," who assert the necessity of equality between the *power* and the *work* necessary to overcome the resistance; while the other class, virtually equate the *power* to the *resistance*. The first class, although on many points they may differ among themselves, concur in the opinion that this procedure on the part of the second arises from mistaken notions on an important first principle, and must, of necessity, lead to fallacious results. Now, opinions, however erroneous, honestly advanced, and defended by fair argument, should be replied to in a manner consistent with the dignity of science, and with a decision which ought not to be considered as implying any want of courtesy. I have, in several Papers, endeavoured to explain the considerations involved in the above distinction of class; and, since Dr. Eckhardt's speculations place him in the second category, these speculations, in my opinion, are opposed to theory and fact, and furnish me with a direct application of a portion of my explanations.

Dr. Eckhardt applies his deductions to the case of a vessel like the *Leviathan*, having 2,490 sq. ft. of immerged mid area, and, when moving at the uniform rate of 16 knots, deduces the resistance to be 552,955 lbs.; "or, dividing by 555 lbs., equal to 996 H.P." The obvious inference is, that 996 H.P., applied without loss, ought to propel the *Leviathan* at 16 knots. Compare this with the result obtained from the singularly successful paddle steam-vessel the *Banshee*. At the same speed, we find that her engines exerted a power of about 1,500 horses, and, making a rough approximate allowance of one-third of the power taken up in working the engine, friction, oblique action of floats, and slip, it would appear that this vessel, of about 190 sq. ft. of mid area, took as much power to propel her as Dr. Eckhardt deduces to be sufficient for a vessel of thirteen times the mid area. An obvious error, as otherwise appears from the following considerations:—

If the resistance at the given uniform speed, for even numbers, be 550,000 lbs. at any instant, a force of that amount must be acting on the vessel.

But a power of 1,000 horses acting on the vessel, means that in one second 550,000 *foot*-lbs. of work are expended in overcoming resistance to motion.

Now, to compare 550,000 lbs., *at any instant*, with 550,000 *foot*-lbs. *in one second*, is to violate an elementary mathematical principle, which declares that quantities cannot be compared, unless they be homogeneous—that is to say, in their essence of the same kind: we must either multiply the first by the space described in one second, to bring it to foot-lbs. per second, or we must divide the foot-lbs. of the second by the space described in one second, and thus reduce it to lbs.

Adopting the first of these, since the vessel moves through 27 ft. in one second, the work done on the resistance is $550{,}000 \times 27$ foot-lbs.; and, since a power of one horse is the capability of performing 550 foot-lbs. of work in one second, to perform the whole work, $\frac{550{,}000 \times 27}{550}$, or 27,000 H.P. would be requisite; adding to this, say, one half, for power necessarily taken up in the previously mentioned sources of waste, it follows, as an inevitable consequence, that, if Dr. Eckhardt's estimate of the resistance be correct, about 40,000 H.P. would be required to propel the vessel at the given speed. Now, this is clearly erroneous, in the face of the fact that the *Banshee*, with 190 sq. ft. of area, was propelled by 1,500 H.P. Even if we take the power directly as the area, it ought not to exceed 20,000 H.P. In the larger vessel, it should be considerably less; and would thus more nearly agree with Mr. Atherton's deduction, page 66, which, reduced to the given draft and speed, would assign 17,000 H.P. as the required power. Dr. Eckhardt's estimate of the effect of form, in diminishing resistance, may be also directly tested by reference to the still better known vessel, the *Rattler*. As an experimental fact, with an immerged mid area of 282 sq. ft., and at a speed of 8·25 knots, the thrust of the screw shaft (the measure of the resistance experienced by this vessel) was 6,215 lbs., or equivalent to a force of 22 lbs. on every square foot of midship area. Now, Dr. Eckhardt's table of resistance, on a plane of 1 sq. ft., at the given speed, would give 251 lbs.; so that the effect of the ends, in this case, is equivalent to multiplying the resistance on the plane by the fraction $\frac{1}{11}$; but, by Dr. Eckhardt's analysis and table, with any form whatever, this fraction could never be less than $\frac{1}{4}$! or about three times as great as direct experiment has yielded, with a vessel of which we have no evidence of the form being the very best possible. Dr. Eckhardt's deductions, in respect to effect of form, are, therefore, directly, and to an extraordinary extent, opposed to known facts. They may be applicable to bodies of the form and size of those on which the experiments he refers to were made; direct application to steam vessels they have none; and he most miserably underrates the talents of the numerous illustrious men who have attempted analytical solutions of the problem, when he supposes that they have failed in perceiving, either in principle or analysis, anything as yet advanced by him. I conclude with a statement of counter opinion:—That the French experiments of 1778 are *not* alone applicable for the purpose to which he refers. The experiments made by the Society for the Improvement of Naval Architecture, in 1796, 7, 8, are, in many respects, superior (as they evidently ought, considering their later date); and I would suggest to Dr. Eckhardt that variations which he hints at, properly followed up, *might* yield true explanations, while the apparently direct course has only led to error. Such experiments doubtless involve the general explanation; but assuredly other elements than the mere angles at the ends enter into its constitution.

Govan, Glasgow, March 15, 1858. Robert Mansel.

PURIFICATION OF THE WATER OF RIVERS.

To the Editor of The Artizan.

Sir,—In The Artizan for March I read with much interest the article from your Dublin Correspondent, in which he describes two methods of preserving the purity of the river Liffey,—one method being to pitch, pave, or flag the river at either side to a very sharp incline, forming in the centre a V-shaped drain,—the other plan is to lay a submerged cast-iron sewer on the bed of the river; each plan designed with a view of carrying off all the refuse matter from the town.

Enclosed is a description of a method, similar, I think, to the latter plan, which I proposed, through the "Manchester Guardian," October 4th, 1855, for effectually carrying off all the refuse matter, &c., from the two large towns of Manchester and Salford, thus preserving the purity of the Irwell, the Medlock, and other smaller streams.

I am, Sir, yours most respectfully, Elias Barlow.

Monton, near Manchester, March 18th, 1858.

"Many complaints have been made of the unsanitary state of the river Irwell. That river, as it now exists, must be allowed by every sanitary advocate to be a very great source of disease to the inhabitants of Manchester and Salford. The cause must also be known to almost everyone, viz., that all the refuse matter accumulated in the two large towns, from various sources, is allowed to be drained into the Medlock and other rivers, from thence as well as through direct sewers, into the Irwell,—so that it becomes a main cesspool for the whole of the two large towns. The subject has from time to time engaged a considerable portion of my attention, which has led me to believe that a most effectual cure might be made of the existing evil. The following brief statement will convey a rough idea of the method I propose, and which I believe would entirely carry away all the refuse matter from the small rivers and sewers emptying themselves into the Irwell, without tainting and polluting the naturally clean waters of that river. I propose carrying all the refuse matter through two submerged main pipes, or sewers, made of cast iron, laid on the bed of the river, one on the Manchester, and one on the Salford side of the Irwell; also, one main pipe or sewer down each small river, to be joined to the main sewers in the Irwell; the two main sewers on the bed of the Irwell to empty themselves at some convenient distance down the river, beyond the termination of the junction of the branch sewers, into one or two large reservoirs, the matter then to be scooped out by scoop-wheels into smaller reservoirs, to allow the matter to settle previous to being used for agricultural purposes. For this purpose the matter is invaluable, and would more than pay the working expenses of scooping out by steam power. The main pipes or sewers would be prepared for the junction of the pipes or sewers of each small river, and the various sized sewers, wherever the situation of such would demand. And to allow for heavy falls of rain, and in case the main sewers would not be able to carry off the floods, ample allowance to be made on the top of each, in the form of safety valves, to allow the escape of the overflow of water, &c., into the river; and also, in case the matter should settle in the sewers, by fixing on the end of each a sluice-valve to open and shut, so as to allow the current of the river to flow through, all the sediment would flush out. When this is done, the sluice to be closed until required again. Although there might appear, at first view, some difficulty in such a system of keeping rivers clear, I believe this method might be carried out entirely and effectually. The expense of carrying it out would be small compared with the immense good it would afford to the inhabitants of Manchester and Salford in a sanitary point alone."

VULCANIZED INDIA RUBBER.

To the Editor of The Artizan.

Sir,—The various purposes to which, during the last few years, india-rubber has been applied, sometimes with very great benefit, and at other times with vexation and disappointment, renders its manufacture a question of considerable importance; and every thing tending to secure a good article to the consumer will, I presume, be of interest to your readers. The great and increasing demand for it has not only raised up manufacturers of knowledge and integrity, but various other persons have attempted to make it who have been quite ignorant of the art,—so have failed to secure a good and useful article; and speculators innumerable have entered upon the business, dependent entirely, not upon the knowledge, but upon the ignorance of their workmen, and the country has been inundated with spurious articles.

For an india-rubber manufactory, the first and most necessary requirement is, that the principal himself should fully understand the business in all its details, without being dependent on any of his workmen; for if any neglect, however small, takes place in its process, the result is fatal to the production of a good and reliable article. It is also of the greatest importance that the manufacturer should be fully informed of the use for which his preparation is intended, so that he may adopt the ingredients accordingly, as one mixture is by no means equally suited for every application; and hence mistakes have arisen greatly prejudicial to the character of the article, and injurious alike to the manufacturer and the public.

It is well known that on the first introduction of vulcanized india-rubber its high quality obtained for it considerable reputation, much more so than is awarded to it in the present day; the chief reason for its being of a uniformly good quality was, that, in consequence of the trade being then in few and respectable hands, there was no temptation to adulterate in order to obtain cheapness, and the goods then made of it were genuine and lasting. Many of the articles produced twelve years ago, after being in constant use, are more perfect now than others which have had only a few months' wear. This difference is caused by competition in price amongst makers of the article, and extensive adulteration consequent thereon, injuring its reputation as a lasting and durable material. Many establishments have opened only to close again, and thousands of pounds have been thrown away but to discover that ignorance and presumption were incompetent to insure success in this branch of manufacture.

Railway buffers, when properly made, and of *good* materials, answer their purpose as well as any springs in existence; whereas the cheap and badly made ones are useless. The latter become in a short time, by use and exposure, hard, and from continual action break and split, which is entirely owing to the want of knowledge and integrity in the manufacturer, the only aim appearing to be to get a large profit on a bad article; whereas, if competent houses were employed, and a proper price paid, the result would be complete and satisfactory.

The adulterations commence, first, by using inferior and cheap gums, which are abundant, and cheap sulphur, which is previously adulterated; then follows various metallic and other compounds, to produce what is termed solidity, but answering little other purpose than giving greater weight, and therefore large profits.

Large quantities of material are spoiled in manipulation by incompetent workmen, and, after having had considerable time and money expended upon it, is frequently committed to the fire only for *fuel*. The curing or steaming process requires also the greatest care and attention; and unless the workman understand the compositions and different heats required, a spoiled instead of a good article is the result.

The variety of purposes to which india-rubber is beneficially applicable is beyond enumeration, and the great deterioration of its value is the desire of adventurers, or cheap manufacturers, who introduce low prices and inferior materials.

Goloshes now in daily use are comparatively cheap, but will not bear a comparison with the golosh made some ten or twelve years back, the latter being as good as when made; the former from one week's wear, will show perceptible signs of wearing out; this is entirely owing to adulterations, and inexperience or bad workmanship.

Upper Norwood, Surrey, March 10, 1858. M. E. Boura.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS, April, 1858.

AGRICULTURAL REVIEW (The), and Journal of Rural Economy and Industrial Science Vol. 1, No. 1, March, 1858. 8vo (Dublin), sewed, 1s. (Whittaker.)

*DANA (D. D.)—The Fireman: the Fire Department of the United States; with a full Account of all large Fires, Statistics of Losses and Expenses, Theatres destroyed by Fire, and Accidents, Anecdotes, and Incidents. By David D. Dana. Post 8vo, illustrated with numerous engravings (Boston), pp. 367, cloth, London. 6s. 6d.

DE LA RIVE (A.)—A Treatise on Electricity, in Theory and Practice. By Aug. De la Rive. Translated for the Author, by Charles V. Walker. 3 vols. Vol. 3, 8vo, pp. 826, cloth, 27s. (Longman).

HOSEASON (J. C.)—On the Rapid Transport of Troops to India, and the Necessity of Navigating the Indian Rivers as the only reliable and speedily available Means of Internal Transport. Dedicated to Lieut.-General Sir De Lacy Evans, G.C.B., and M.P. By John Cochrane Hoseason. With coloured Map, 1s. (Stanford).

HYMERS (J.)—A Treatise on the Theory of Algebraical Equations. By J. Hymers. 3rd edit., 8vo. (Cambridge), pp. 290, boards, 10s. 6d. (Bell.)

*PIGGOT (A. S.)—The Chemistry and Metallurgy of Copper; including a Description of the Principal Copper Mines of the United States and other Countries, the Art of Mining and Preparing Ores for Market, and the various Processes of Copper Smelting, &c. By A. Snowden Piggot, M.D. Post 8vo (Philadelphia), with illustrations, pp. 381, cloth. London. 7s. 6d.

ROSENGARTEN (Architekt A.)—Die architektonischen Stylarten. Eine kurze, allgemeinfassl. Darstellung der charakteristischen Verschiedenheiten der architektonischen Stylarten. Mit 426 Illustr. R. 8vo. (Braunschweig). 10s. 6d.

STEVENS (R. W.)—On the Stowage of Ships and their Cargoes. By Robert White Stevens. 8vo, cloth, 5s. (Longman.)

TAYLOR'S Original and Improved Builders's Price Book. Edited by James G. Smither. Crown, 8vo, pp. 156, sewed, 4s. (M. Taylor).

* American Works.

LAW CASES.

HANCOCK AND OTHERS *v.* ROSS.

Rolls Court, Chancery-lane, March 2.—This suit was instituted by the members of the well-known firm of Charles Macintosh and Co., caoutchouc manufacturers, for the purpose of restraining the defendant from infringing a patent right obtained by Mr. Thomas Hancock, in November, 1843, for the exclusive use of vulcanized india-rubber, for the purpose of making overshoes and other articles. An injunction was granted by his Honour in August, 1855, but was subsequently discharged upon the defendant's entering into an undertaking to keep accounts of the articles sold by him which fell within the principle of the patent right. It appeared that several actions had been tried for the purpose of testing the validity of this patent, which uniformly had resulted in establishing it; and in one of such actions an agreement was entered into between the plaintiffs and defendant, to the effect that the latter should be at liberty to dispose of the stock he had on hand upon paying a royalty to the plaintiffs in the purchase of labels and stamps, to be placed upon the overshoes and articles of the particular manufacture alleged to have been patented. The question now submitted to the Court by the Plaintiff was, that the defendant had violated this contract by importing large quantities of overshoes from America since the date of the agreement, which did not form part of his stock at the time of the contract. The defence was, that the defendant was to be allowed to sell the number of 80,792 pairs of overshoes, and that he had not yet reached that limit. It was also contended that the plaintiffs, by their course of dealing with the defendant, had acquiesced in the defendant's selling unlimited numbers of overshoes, provided the royalty agreed upon was paid down to the month of November, 1857, when the patent right expired.—His Honour intimated that he would take time to consider his judgment.

THE QUEEN *v.* MACNEE.

Earl Marshall's Room, House of Lords, Feb. 18th, 1858.—This was an application to Her Majesty's Attorney-General for leave to issue a writ of *scire facias* to repeal certain letters patent granted to the defendant, Mr. James Macnee, of Glasgow, in January, 1852, for certain "improvements in the manufacture and production of ornamental fabrics, known in the trade as printed zebras;" a fabric extensively exported to the Turkish and Eastern markets. The case was argued by Mr. Webster, in support of the application, and by Mr. Hindmarsh, on behalf of Mr. Macnee, the patentee. It appeared from the documents laid before the Attorney-General, that Mr. Nimmo, of Pendleton, was the original applicant for leave to issue the *scire facias*. The Attorney-General shortly reviewed the facts, and referred to a contract entered into in January, 1856, to which Mr. Nimmo, and also Mr. Macnee, Mr. Samuel Higginbotham, and others, now interested in the patent, were parties, in which Mr. Nimmo admitted the validity of the patent, and he therefore refused the application.

NOTES AND NOVELTIES.

MISCELLANEOUS.

Engineering in Victoria.—A few extracts from the list of "Contracts Accepted" in the "Melbourne Examiner and Weekly News," will show our readers what is going on. Lighthouse, &c., Wilson's Promontory, £12,920—P. S. Sinclair; two cranes at same place, £480—C. Johnson; powder magazine, Mélbourne, £4,234—J. Duncan; Telegraph Station at Beechworth, £1,100—McLuckie and Carter; ditto at Longwood, £985—A. Amos and Co.; ditto at Portland, £1,183 13s.—Sedgwick and Jones; Schnapper Point Jetty, extra work, pitching slopes, £169—Jenkin Collier; St. Kilda Jetty, extra work, piling and pitching slopes, £423 6s. 8d.—A. Crawford. Supply of English steam coal, as may be required for the service of the steam sloop, *Victoria* * during the year 1858, £3 3s. per ton—Dove and Oswald; Lighthouse, Cape Schanck, £8,950—Coney and Francis; Hull, &c., of steam dredge, £7,173—J. Burgoyne.

The Widow and Child of the late Mr. John Henderson, lately of the firm of Fox and Henderson, have been left penniless. A Committee has been formed in London to receive subscriptions, consisting of Messrs. Brassey, May, Jackson, Grissell, and Horsey. Another influential Committee has been constituted at Birmingham.

An Association has been formed, in connexion with Price's Patent Candle Company, *to provide dwellings* at Battersea *for the workpeople* in that establishment, a similar experiment at their factory near Liverpool having been successful.

Photographic Reports of the Progress of Engineering Works.—Photographic reports of the Soane Bridge, now constructing in the East Indies, have been forwarded to this country. "Mr. Vignolles, C.E., and Mr. Hyde Clarke, have the credit of having first introduced the plan elsewhere; and it is understood Mr. Stephenson is now carrying it out with respect to the works of the Victoria Bridge over the St. Lawrence."—*Herapath.*

Nature Printing.—The King of Sweden has presented a gold medal of merit to Mr. Henry Bradbury.

We understand that John S. Sloane, C.E., a Dublin gentleman, of antiquarian and ecclesiological celebrity, is preparing a work on the river Liffey from its source to its mouth, profusely illustrated with sketches by the author, and notices of the various objects of interest, natural and antique, that so abound along the course of that river.—*Illustrated News of the World.*

Mr. Griffiths, the distinguished Irish civil engineer, is to be made a baronet.

The Derwent Iron Works are likely to be soon again in operation, having been taken by an influential company.

A number of engineers and workmen, under the guidance of M. Dégoussée are going to pierce Artesian Wells in the Desert of Sahara.

Commissioner Murphy, in the Insolvency Court, has decided that, under the new stamp law, a penny stamp suffices for a receipt in full; formerly a 10s. stamp was needed.

Zinc Roofing.—Dr. Pettenhoffer states that a zinc roof is oxidized to the extent of 130 grains per square foot in 27 years, nearly one half of the oxide thus formed being removed by the moisture of the atmosphere.

Explosion of an Iron Pillar Letter Box at Manchester.—A man having been seen to run away from the letter box, the policeman, suspecting mischief, opened the lid of the aperture for the reception of the letters and flashed the naked light of his lantern across it, when an explosion took place, injuring the officer, and sending a large piece of iron to the distance of 150 yards. The explosion was caused by an escape of gas from the main into the letter box.

RAILWAYS, &c.

Cornwall Railway.—The report of Mr. I. K. Brunel, the engineer, states that during the last half-year the first, or western, span of the Saltash Bridge has been floated into place, landed on the piers, and the raising commenced. This operation has proceeded, under the personal direction and superintendence of Mr. Brereton, steadily, and in every respect satisfactorily. For some past the bridge has been lifted and piers built up at the rate of 6 ft. per week; and at this rate will be up to the level of the tops of the iron columns, or upwards of two-thirds of its intended height, in the course of a fortnight. There is reason to hope that, with favourable weather, the bridge may be completed during the present year. Upon the whole of the rest of the line little beyond the superstructures of the Liskeard Viaduct, the timber viaducts between Plymouth and St. German's, and the piling and superstructure of the St. German's Viaduct, remains to be completed. The laying of the permanent way remains to be completed.

East Suffolk Railway.—Mr. G. Berkely, the engineer, states in his report that the works on the main lines are nearly completed; that the whole of the works on the railway are of the most substantial and convenient kind, and that the present rate of progress continued will complete the main line, with the Leiston and Snape branches, in July; and the Yarmouth and Lowestoft, together with the Framlingham branch, early in September next.

Colne Valley and Halstead.—The first sod has been turned. A Committee has been appointed to promote the extension of this line to Cambridge. Engineer, Mr. Beardmore; assistant engineer, Mr. Despard.

Mid-Kent.—The extension to Croydon has been abandoned—a short junction with the Brighton line being contemplated instead.

Wells and Fakenham.—A junction has been effected with the Eastern Counties and Norfolk Railways, and the branch to the harbour at Wells has been finished.

Bourne and Essendine.—The works will shortly be commenced. The rails, chairs, &c., have been purchased.

Beattie's Smoke-Burning Locomotives.—Two of these have been used on the East Lancashire Railway Company for two months, and "had answered expectation."

Salisbury and Yeovil.—The works are now being pushed forward vigorously.

Severn Valley.—The tender of Messrs. Brassey, Peto, and Betts has been accepted (£363,000). The whole cost of completion will be about £530,000. The line will be worked by the Oxford, Worcester, and Wolverhampton.

Lowestoft and Beccles.—The works are proceeding; the line will be completed in September.

South Wales.—The terminus at Neyland will shortly be lighted with gas. The new arrival platform is ready. The traffic between Neyland and Waterford (Ireland) is so rapidly increasing, that an additional steamer will shortly be necessary.

The Rhymney line has been opened to Cardiff.

Glasgow and South Western.—The report of Mr. Johnstone, the engineer, states that the Company's new workshops, at Kilmarnock, are now in full operation, and the greatest benefit is felt from the facility with which repairs can now be executed.

Aberdeen and Inverness Junction.—The works on this line are progressing favourably; the rails between Dalny and Elgin are nearly laid; and the line from Inverness will be opened to Elgin next month. The remaining portions of the line are in a forward state, and are expected to be completed in time, so that the whole line from Aberdeen to Inverness may be opened early in the summer.

* A large plate of the engines, and a description of this vessel, were given in The Artizan, November, 1855.

East Kent Railway.—The junction of this line with the North Kent Railway at Strood is now completed, and immediately after the Government Inspector of Railways certifies its fitness for traffic, it will be opened to the public, making, with the portion already in operation, 20 miles from Strood to Faversham. The Company's bridge over the Medway was tested, as to its strength, on Tuesday. A long train of trucks, laden with bricks, passed to and fro over the bridge, and it was stated that the centre span showed a deflection under the load of 1 inch and 6-10ths, which was considered very satisfactory.

Strasbourg Railway.—Two sections have been opened. The first is from Bellefort to Dannemarie, a distance of 25 miles, with five stations. The second is from Langres to Vesoul.

The entire line between Paris and Mulhouse will shortly be opened for traffic.

The Bordeaux and Cette Line.—The section between Narbonne and Perpignan, 40 miles in length, was opened on the 20th inst.

Marseilles to Toulon.—The works are reported to be advancing rapidly.

The "Moniteur des Intérêts Matériels" describes an improved contrivance for signalling on railways, invented by Mr. Barnawski. The invention consists in the employment of a quantity of mercury (about nine quarts), which, upon the passage of the train, is forced into a cylinder, and, acting upon the signal, places it in the position to denote danger. The mercury is then allowed gradually to escape, whereby the signal is brought to its primitive position in about ten minutes. Some experiments have been made at the Vauterre station on the Paris and St. Germain line, and proved successful.

Lyons and Geneva.—The section from Seyssell to Geneva was to be opened on March 18th. The Government has ordered that a plan for preserving the town of Vierzon and the Orleans Railway from the inundation of the Cher, shall be examined by competent engineers. The cost of the works is estimated at 205,000 francs.

Hainault and Flanders.—From Renaix to Audenarde the works are in progress. From Renaix to Leuze will next be proceeded with.

The Sprielberg Tunnel is commenced.

The Madrid to Badajos is likely soon to be commenced.

Railway Communication is now completed between *Madrid* and *Alicante.*

By a temporary bridge over the Jarama, the section of the *Madrid* and *Saragossa* line from Madrid to Guadalajara can be opened in June.

Mr. C. Vignolles, C.E., is expected at Bilboa. A line is shortly to be commenced from that town. *Tarras* to *Mauresa* is rapidly advancing. *Central Barcelona.*—The first stone of the important bridge over the Llobregat has been laid.

The Berlin and Konigsberg Railway is to be continued to the Russian frontier. The Government will propose a loan of 12,500,000 thalers for that purpose.

Italy.—Nothing has yet been decided as to the Puglia line, to connect the Mediterranean with the Adriatic. Mr. Charles Longridge has a commission to provide the rails for the line between La Cava and Salerno, and, in the event of the Taranto line not being completed, will lay down the telegraphic wires on the same line.

The Tunnel through Mount Cenis.—On the east side, 100 metres have been pierced; on the west side 85 metres.

Turkey.—Samsoun Sivas Line.—Messrs. Austin, Graham, and Drew, civil engineers, made the necessary surveys. The line will be 250 miles in length.

The construction of the railroad between *Petersburgh* and *Warsaw* is progressing rapidly. Last year it was opened as far as to Luga, a distance of 134 versts, by the roads previously in existence. In this year it is held out that a further space betweeen Luga and Pskow, a distance of 110 versts, will be opened. In the following year the distance between Pskow and Dünaburg is to be finished.

Russia.—An Imperial decree sanctions the establishment of two new railways, the *Vienna-Warsaw* and *Warsaw-Bromberg* Companies.

Locomotive Engine for the Pacha of Egypt, by Messrs. Sharp, Stewart, and Co., Atlas Works, Manchester.—An inside cylinder engine, six wheels, coupled; wheels, 5 ft. diameter; cylinder, 17 in. diameter; stroke, 24 in.; heating surface, 1,167 sq. ft.; tender, six wheels, 3 ft. 6 in. diameter; tank, 1,400 gallons of water, and 20 cwt. of coke; weight of engine and tender in working order, 45½ tons; estimated duty, 600 tons at 20 miles per hour on level.

United States, Millwantrie, and Mississippi.—The Southern branch has been opened. The *Pacific* railroad is to be constructed between the Big Sioux and the mouth of Kansas river to San Francisco. The *Mine Hill* line has been extended about ten miles, and the *Mount Eagle* line about five, making, in Schuykill Co., 488 miles, for the accommodation of the coal trade.

Trinidad.—A concession has been received from the Colonial Government. The chief provisions are a £6 per cent. guarantee, a grant of 1,000 acres of land per mile of railway, the timber and minerals on and under these lands, the right of cutting timber on the Crown lands for the construction of the line, and the free importation of all materials.

Pernambuco Railway.—The first section was opened February 8.

TELEGRAPH ENGINEERING, &c.

Submarine Cables.—M. Baudouin has recently forwarded a paper to the Academy of Sciences "On means for preventing the Breakage of Electro-Wires and Submarine Cables." M. Baudouin asserts that there is no use in making thick cables when the thickness consists in an outward envelope designed to protect the electric wires, and not to benefit them in any way. Hitherto a certain number of copper wires have been covered with insulating materials and then placed in a common insulating envelope, which thus forms the inside of an iron wire cable. All the resistant strength of the cable is in the iron-enveloping wires; but, however strong this metallic covering may be, it will stretch considerably under great strain, which, in the case of iron wire, only disturbs the coils without injuring the material; but which in the case of copper wires placed in the middle of the cable, distends or draws out the particles of metal and snaps them, so that the cable itself does not break, but the electric wires inside the cable. Red copper is extremely ductile, it is true, and can support to a considerable stretching without breaking; but this stretching has its limits, and when they are passed, the metal, if soft, as it may be, is broken, and the electric communication interrupted, as has just occurred in the Mediterranean. To obviate this inconvenience, M. Baudouin was led to reverse the method of making submarine cables; to place in the interior the elements of strength and elasticity, and to use the iron wires thus placed as conductors of electricity. Thus, in a Transatlantic cable, M. Baudouin proposes, instead of copper wire, which forms the conductor, to substitute a cord of iron wire, six times and a half as thick as ordinary copper wires, in order to get an equivalent conducting power. Six iron wires of three thirty-seconds of an inch each in diameter wound round a centre, and covered with bituminized hemp, would suffice. The metallic cord thus formed would be nine thirty-seconds of an inch in diameter; it would unite great flexibility with considerable solidity, and would easily support a weight of 2,400 pounds. Instead of seeking to multiply the number of electric conductors in one cable, M. Baudouin is of opinion that it would be preferable to divide them into several distinct cables, so as to make them lighter and divide the chances of accidents.

The Electric Wire is to supersede the old arm telegraph *for Admiralty purposes.*

Police Station Telegraph.—A few of the principal metropolitan stations are to be connected on the plan by which Messrs. Waterlow and Sons' establishments in Birchin Lane and London Wall communicate. We think it desirable that not only the police stations but all the stations of the Brigade and other fire engines should be similarly connected.

The Turkish Government is about to open a telegraphic communication with Greece, and that kingdom has announced its intention to lay down a wire to Zante, as soon as that island is brought into connection with Corfu and Trieste.

Russia—United States.—There is a project now at St. Petersburg for carrying a telegraphic line thence by way of Siberia, sinking a submarine cable between Capes East and Prince of Wales, and continuing it so as to join the lines passing through the British Possessions, to the United States.

France and Algeria.—The communication is at present interrupted, owing to some disarrangement in the cable from La Spezzia to Corsica.

Atlantic.—A new attempt will be made, probably in May or June, to submerge the electric cable between Ireland and America.

MILITARY ENGINEERING, &c.

Coast Defences.—Sunderland, Mouth of the Wear.—The Royal Engineers have decided upon recommending Government to place a battery of four guns on a line with the Blue House, a battery of four guns on the large bank to the south of Roher-terrace, a battery of eight guns on the north side of the south inlet of the New Dock, and a battery of four guns on the south side of the sea outlet. The guns to be of 10 in. bore.

Aberdeen.—The Ordnance Department are now engaged in erecting three batteries for the defence of the port and city of Aberdeen.

Stockholm.—The Council of State have voted 100,000 rix dollars for the preparatory works of the fortifications of that capital.

A New Armoury is to be erected at Albany, U.S., at a cost of 25,000 dollars, from the plans of Mr. William Hodgens, formerly City Engineer of Hamilton.

Portsmouth.—A line of fortifications is to be formed at Hilsea, near Portsmouth, to be carried round to Port Cumberland. The creek at Portsbridge is also to be deepened and widened, to enable the gun-boats to pass completely round the island. The old 24-pounders on all the south coast are to be replaced by 74-pounders; electric telegraph communication to be established between the whole of the fortifications forming the south and eastern defences.

MARINE ENGINEERING, SHIPBUILDING, &c.

Dr. Livingstone's Launch is in form simply a large flat-bottomed canoe, each end having a great rise like those craft which, from their handiness in turning or putting ashore if necessary, are the best adapted for shallow river navigation. The hull is divided into three sections, each complete and watertight in itself, the centre section containing the boiler and machinery, which is a horizontal high-pressure engine, of twelve-horse power, the piston-rod working directly on to the paddle-crank, similar to the arrangement of a locomotive engine. The different parts are connected by a plan patented by Mr Macgregor Laird some years ago. At the bottom of each end of the centre section are projecting ledges with holes in them. These ledges or arms extend under the adjoining sections, and the holes receive small pins fitted in the lower part of the other sections. The upper portions of the transverse plates, forming the water-tight ends of each section, are also bolted to each other, and the whole vessel is thus compactly tied together. There is a flat keel and broad external-stringer plates, of greater thickness than the other portions of the hull, running the full length of each section, thus giving great additional lateral strength to the vessel. To her after end is attached a framework of iron rods, on which the rudder is hung. The rudder hangs lower than the bottom of the vessel, for her draught is so light (about 14 in.) that otherwise it would not have sufficient power in directing her course. The fore and after sections are fitted up for the accommodation of those employed in the expedition. The depth of the hull is so small that, of course, the usual sleeping-berths are out of the question, but the most has been made of the limited room; and each end of the vessel will be covered in with awnings, so that it will be something like living in a tent, with the additional advantage of always having a dry floor. There will be seats below the level of the deck, like those in the sternsheets of a river barge, with "bunks," or slide-lockers, above them, for stowing provisions and stores. The building of the launch and making of the engine were commenced 4th January, and the engine was tried on the 6th February, an instance of expedition that could only be accomplished by the vessel, engine, and boilers all being made at one establishment. The three sections of the launch were then lowered into the water by a crane, and put together while afloat. Two trials have since been made of the launch in the river Mersey, and the result was most satisfactory, the engine making seventy to eighty revolutions with 50 lb. steam, and the vessel attaining a speed of nine miles an hour on a draught of water of about 13 in. The model of the launch is the same form as that patented by Mr. Laird, and on which he has built so many vessels for the Hon. East India Company for navigating the rivers of India—viz., both ends alike, with a curved keel, not having what is technically called dead wood or gripe, but composed of curves, which form enables the vessel to turn quickly, and to be more easily got off shoals in case of getting aground.

Holyhead New Mail Service.—The new packets to be provided for the improved mail service between Holyhead and Dublin are to be four in number, and each vessel is not to be less than 300 feet in length, and of 1,700 tons measurement. The contract has actually been taken for vessels of 2,000 tons and 700 H.P., the speed to be superior to that of the Queen's yacht, the *Victoria and Albert*—17½ knots an hour. The voyages are to be four daily—viz., two from each port. Messrs. Laird, of Liverpool, build two, and Mr. Samuda, of Blackwall, the other two; and it is expected that the communication between London and Dublin will be reduced to eleven hours.

The Turkish Government have chartered at Antwerp the *Harriet Hoxie* to take on board at Havre the *shallow-draft steamer*, *Omnibus*, which is to run from Bussorah on the Persian Gulf to Bagdad on the Euphrates. The steamer is iron-built, and will be taken out in pieces. A complete assortment of tools and apparatus for the repair of machinery goes out to form a workshop at Bagdad.

The Peninsular and Oriental Company's steamship, *Ava*, has been *lost*. She was an iron vessel of 1,730 tons, builders' measurement, and 320 H.P., built by Messrs. Tod and McGregor, of Glasgow, and launched in May, 1855.

New Screw Steamers for the Navy to be completed at Chatham, and launched during the ensuing summer:—*Hero*, 91 guns, 3,300 tons burthen; *Hood*, 90 guns, 3,000 tons; *Mersey*, 40 guns, 3,000 tons; *Charybdis*, 21 tons, 2,500 tons.

The Screw Steam Gun-Boats at Gosport.—An inquiry having been made as to how soon 50 gun-boats could be got ready for service, a trial of the new machinery just completed by Messrs. Humphrys, Tennant, and Dykes, was made (March 12). The machinery principally consists of an enormous endless screw, 126 ft. in length, by 6 in. in diameter, and weighing 4 tons. It is in one continuous piece. A gun-boat of 80 horse-power was drawn out of its shed across the transverse lines to the launching rails in the short space of six minutes. It is estimated that in little better than 48 hours 50 gun-boats could be afloat and under steam.

Her Majesty's ship *Renown*, 91, Captain Forbes, was tried in her sea-going trim for the first time, at the measured mile, in Stoke's Bay, by order of the Admiralty, who were particularly desirous of ascertaining her capabilities before ordering her to sea. Her engines are of 800 horse power, by Penn and Son, whose superintending manager, Mr. Wigzell, was at Portsmouth to watch the trial. Mr. Dinnen, Inspector of Machinery, of Somerset House, attended to report for the Admiralty. The ship ran the course six times, which realised a mean speed of 11·5 knots; the mean of the two best runs gave a return of 11·7; pressure of steam, 20 lb. steady; revolution (mean) 54½; mean draught of water, 23 ft. 8 in.; pitch of screw, 28 ft., diameter of screw, 19 ft. The engines worked satisfactorily, and the ship steered and moved very easily.

Iron for War Ships.—Sir Charles Napier, in a late speech, says that a 20 gun ship, lined with iron 4 in. thick, will in "a very short time destroy a three-decker of 100 guns."

The "Aboukir," built as a sailing 84, but converted into screw, after the manner of the *Goliath*, by the addition of engines of 400 H.P., by Penn and Son, was tried at moorings at Devonport, on March 13th, and is reported to be ready for a trial at sea in ten days' time.

Pembroke.—The *Orlando*, screw frigate, 50 guns, is the first of six ordered to compete with the American frigates. She is the largest frigate in the service, being about 360 ft. in length over all.

At a meeting (February 27th) of the *General Iron Screw Collier Company* it was unanimously resolved to wind up.

Sunderland.—The screw steamer, the *Asia*, has just been launched from the yard of Mr. James Laing. She is a full rigged iron vessel; length, 220 ft.; breadth of beam, 24 ft.; depth, 21 ft.; tonnage, 1,150 tons O.M.; poop, 70 ft. in length; saloon, 45 ft.; engines, of 400 H.P., by Morrison, Ouseburn Works.

Middlesborough.—The first iron vessel built here has just been launched—a screw steamer. Length over all, 156 ft.; between perpendiculars, 147 ft.; breadth, moulded, 20 ft.; depth of hold, 11½ ft.; load-draft of water, 10 ft.; tonnage, O.M., 287 tons; register, 288 tons.

Hull.—The shipwrights are on strike.

Birkenhead.—Mr. Laird has launched the *Emperor Alexander*, an iron screw steamer, for the Russian Government, to ply between Odessa and Alexandria; burthen, 1,100 tons; H.P., 300 nominal, 1,200 actual.

Dimensions of *Leopard*, built by Denny and Sons, Dumbarton; engines by Tulloch and Denny, of 320 H.P. nominal; length between perpendiculars, 222 ft. nominal; length on load line, 219 ft.; length on deck, 229 ft.; breadth between paddles; 27 ft.: breadth outside ditto, 45 ft.; tonnage—builders' measurement, 800 tons; register, N.M., 435 tons; side lever engines; tubular boilers, with Muir's patent apparatus for heating the feed water; diameter of cylinders, 66 in.; length of stroke, 6 ft. 3 in.; draft of water, 4 ft. 10½ in.; ditto when loaded, 9 ft. 9 in.

The Collins U.S. Mail Steamers have ceased to run between Liverpool and New York, and in consequence of their withdrawal, the Cunard Company are about to establish a line of communication between the two ports, with their full powered screw steamers, the *Etna*, *Alps*, *Jura*, and *Palestine*.

Steam Line between Virginia (U.S.) and France.—A contract has been entered into between a company—the Orleans Railroad Company of France. The number of ships to be four; two built in Norfolk, Virginia to bear the American flag, and two in France, to bear the French flag. The tonnage of each vessel to be not less than that of the *Arago*. The number of trips not less than 24 per annum.

Five Steam Boats have been *destroyed by fire* at New Orleans.

A New Screw (Yacht) Frigate, *Bartolomeo Diaz*, 18 guns, has been completed at Blackwall, for the King of Portugal.

Russia.—The Black Sea.—The Emperor authorised the Russian Society of Commerce and Navigation, established to effect regular steam communication between Odessa, Yalta, Kertch, and Redoute Kalé, to extend its operations from the latter place to Trebizond, a distance of 115 miles, and has granted the company a subvention.

Steam Navigation in Southern Russia.—Another of the large fleet of iron steam-vessels building in this country for the Russian Steam Navigation Company will leave the Tyne in a day or two for the Black Sea, where she will be employed in bringing to market the produce of the extensive coal fields of Southern Russia. The vessel alluded to is the large iron steamer *Oudaloy*, built by Messrs. Charles Mitchell and Co., of Walker-on-the-Tyne. The steaming and carrying properties of this fine vessel have been well tested; the amount of cargo carried being 200 tons in excess of the stipulated quantity at a fixed draft of water. Extensive orders are being executed in England for the supply of iron vessels to navigate the Russian waters. Messrs. Charles Mitchell and Co. have recently entered into large contracts for building those vessels, and from the peculiarity of the service, some of them will be of unusual proportions, and quite unlike any vessel employed in this country. As an example, Messrs. Mitchell are constructing a paddle steamer 200 ft. long, upwards of 30 ft. broad, which, when fully laden, will only draw 18 in. water. The form of the hull is peculiar, the bow being shaped like a spoon, to overcome the difficulties of the navigation. The cabins are fitted on deck, and the vessel will resemble the steamers used on the American rivers more than anything known in this part of the world. The framework of the hull is equally peculiar, all the elements being so combined as to produce the greatest possible strength with the least amount of weight

Iron Shipbuilding.—The Russian Government have issued an ukase, allowing the importation of pieces of metal and machinery into Russia duty free, when these are to be employed in the construction of ships on account of subjects of the empire.

Clifford's Boat-Lowering Apparatus.—The Government of Victoria have gazetted a notice that all colonial steamers, on and after July 1, 1858, are to be provided with Clifford's patent, or one, in their opinion, equally efficient.

The Chilian Government Steamer *Maria Isabel*, recently purchased in England for 200,000 dollars, has been lost in Misericordia Bay, in the Straits of Magellan.

STEAMER "GENERAL CONCHA."

Owners, Pesant Brothers. Hull built by Lawrence and Foulks; Engines by Bribecks and Hodges, New York.

	ft.	in.
Length on deck	110	0
Breadth of beam (moulded)	27	0
Depth of hold to spar deck	9	0
Area of immersed section at load draft of 7 ft	160 sq. ft.	
Hull / Engine room	220 tons.	

Description of engines, inclined direct; ditto boiler, return flued; diameter of cylinders, 28 in.; length of stroke, 4 ft.; diameter of water wheel over boards, 19 ft. 6 in.; length of wheel blades, 4 ft. 3 in.; depth of ditto, 1 ft. 10 in; number of ditto, sixteen; number of boilers, one; length of ditto, 20 ft.; breadth of ditto, 7 ft.; height of ditto, exclusive of steam chimney, 7 ft. 4 in.; number of furnaces, two; breadth of ditto, 3 ft.; length of grate bars, 6 ft.; number of flues above, five; ditto ditto below, ten; internal diameter of ditto above, 1 ft. 1 in.; ditto ditto below, two of 12 in. eight of 8 in.; length of ditto above, 15 ft.; ditto ditto below, 11 ft. 6 in.; diameter of smoke pipe, 2 ft. 9 in.; height of ditto, 18 ft.; draft forward, 7 ft.; ditto aft, 7 ft.; date of trial, December, 1857; heating surface, 740 sq. ft.; maximum pressure of steam, 25 lbs.; point of cutting off, ⅞; maximum revolutions at above pressure, 22.

Frames, moulded, 11 in.; sided, 6 in.; 22 in. apart from centres. Depth of keel, 6 in.; independent steam, fire, and bilge pumps, one; masts, one; rig, sloop.

Remarks.—This vessel is built for account of H.C.M.'s Government in Cuba, and is designed for towing. Her engines are not connected one with the other.

The Model of a New Paddle-wheel, patented *by Mr. W. W. Muntz*, son of the late member for Birmingham, has been exhibited at Liverpool. The wheel is of very novel construction, the floats being made of boiler-plate iron, and divided into two pieces. The wheel consists of a large middle rim or circle, with two small circles for side rims. The two portions of the floats are placed at angles to each other, the base of each float being fixed into the outer small rims, their points meeting in the form of a triangle on the large centre rim. The floats thus enter and leave the water with much less concussion and lift than the ordinary horizontal floats, saving, of course, a great expenditure of engine power, while, at the same time, it is contended the peculiar form of the angular float gives much

greater propelling power. An additional advantage is, that by building the paddle-boxes sharp to a point, fore and aft, as well as at the top—adapting them thus to the shape of the wheel itself—they are enabled to offer little or no resistance to the air, and may, if necessary, be detached and used as life boats. The invention has been practically tested at New York, with, it is said, the most successful results, much of the usual vibration being prevented. Messrs. Taylor and Lewis, of the Britannia Foundry, at Birkenhead, are the agents for Mr. Muntz —*Liverpool Albion.*

The attempts to raise the sunken Vessels at Sebastopol have proved complete failures. It is said that eighty-one vessels were sunk, not one of which has been recovered. The vessels belonging to the American Wrecking Companies have returned to Constantinople, and have been advertised for sale. An American contemporary, in allusion to the employment of these vessels, crowed exultingly that the Emperor of Russia had been obliged to send for American engineers, as European engineers could not recover the sunken vessels. The *teredo navalis* has, however, put it beyond the power of either, and will, in progress of time, clear the harbour for the entrance of vessels.

HARBOURS, DOCKS, CANALS, &c.

Devonport.—A line of military defences is to be erected for the protection of the Dockyard.

Chatham.—Among the works ordered to be undertaken at Chatham Dockyard, is that of extending No. 2 dock inwards, in order to render it capable of receiving line-of-battle ships: the estimated cost required this year for the undertaking is £47,000. The extension of No. 3 dock is proceeding, and the works are in a forward state. £26,000 will be required to complete that basin. The roof of the resting is also to be extended, at an expense of upwards of £2,000; and works commenced for a better water supply for the Dockyard. It is intended to extend and improve Chatham Dockyard, by means of convict labour, at an estimated cost of £142,000.

Opening of New Docks at Newport.—The works have been carried out by Mr. Abernethy, C.E. The dock occupies an area of 8 acres; length, 950 ft.; width, 350 ft.; total cost, £64,000. The communication between the old and new dock is by an opening in the north end of the former, made to permit the use of a caison when occasion requires; seventy-five vessels, averaging 500 tons, may at one time be berthed. Special provision is made for timber vessels. The coal hoists, turntables, cranes, and capstans, will be worked, and the locks opened and shut by hydraulic machinery, manufactured, we are informed, by Messrs. Armstrong and Co., of Newcastle.

Cardiff.—A New Graving Dock has been erected for Messrs. Hill, of Bristol, at the north extremity of Cardiff West Dock.

Chatham Dockyard.—The basin which is being constructed for the reception of the largest vessels in the navy, is rapidly approaching completion. The new dock is nearly 400 ft. in length, and 92 in width; depth, 31 ft.

Jarrow Docks.—The quay-walls are nearly finished. Progress is making with the shipping jetties, and one of the spouts, on a new principle, is finished. Workmen are busy with the 64 feet lock gates.

Harbours of Refuge.—A breakwater in St. Ives Bay is recommended by the Cornish people, while the Bristol Chamber of Commerce is in favor of a harbour at Clovelly. The coasts of the Channel have been surveyed by Captain Claxton, R.N. The inhabitants of Swansea have set forth the claims of the Mumbles to a breakwater, which, they state, would render the splendid bay of Swansea a complete refuge harbour.

The Danube.—The works undertaken to blow up the rocks of the Iron Gates have been resumed. One rock, which was 4 feet above high-water mark, has been so completely removed that large vessels can effect a passage over it.

Isthmus of Suez Canal.—The Viceroy of Egypt will, it is said, in the case of the refusal of the sanction of the Porte, authorise the undertaking of his own pleasure.

A Patent Slip Dock is to be constructed at *Kingston, Jamaica*, capable of taking up vessels of 3,000 tons register.

Docks at Quebec.—It is contemplated to provide deep water wharfs for ocean steamers, and lake and river craft, with suitable storage for all kinds of merchandise, in direct communication with the Grand Trunk Railway Station, affording all the security of enclosed docks and warehouses, with a timber cove, capable of holding four millions of feet.

BRIDGES.

Caerhowell Suspension Bridge.—(See The Artizan, February 1, page 47.)—At the inquest Mr. Evan Hopkins was examined, and strongly condemned the bridge, as far too weak a structure for the heavy traffic constantly passing over it. Where the roadway, too, was constructed in so much heavier proportion than the upper part of the bridge, the passing over of heavy traffic was unsafe and dangerous. He had seen a great many of these bridges, but not one so large and with so heavy a roadway. The sectional area was strong enough, but not with bars of the size. A great deal of the iron was hot blast, and of very inferior description. Extra ballast had been recently put on. Some of the rods, no doubt, first gave way, and the rest were not sufficient for the emergency. He disapproved of the strength of the rods, but not of the principle of the bridge. The bridge was not strong enough for ordinary purposes. The Jury, after a lengthened consultation, returned the following verdict :—"We find that the death of Richard Grist was caused by the falling of the Caerhowell Suspension Bridge on the River Severn, that bridge not having been constructed or maintained in such a manner as to afford security to life and safety to property passing over in the ordinary way of traffic; that some of the defects consisted in the inferior quality of the iron, and workmanship badly performed—circumstances which might have been avoided had there been proper supervision by a person acquainted with the original plan and mode of construction. We feel it a duty not to separate without expressing our opinion that the present fatal catastrophe shows the necessity of greater vigilance on the part of the county authorities, and that safety and durability, rather than economy, should in future guide them in all public works."

Whittlesea.—The railway bridge which has been some months in the course of construction has been opened for traffic. It was designed by Mr. R. Sinclair, engineer to the Eastern Counties Railway Co., and the work executed by Bennet and Son, of Whittlesea.

A Company is about to be formed for the purpose of *connecting East and West Cowes by a floating bridge.*

Bridges in Australia.—Mr. George Bate, a practical engineer, has constructed a timber bridge, on a new principle, over the river Murray, at Echuca. The peculiarities and advantages consist in an arch built after the manner of the felloes of a wheel—a cohesion beam above, a tension beam below, crossed by radii springing from a common centre, the whole so knit together that external abutments are unnecessary, added to which are cheapness and rapidity of construction, lightness, and convenience of transport. The bridge over the Murray is erected on pontoons, and consists of ten arches, 33 ft. long, 27 ft. span, and 10 ft. wide. A similar bridge was then designed to cross the Campaspe River. The quantity of timber used in this latter bridge is 1,200 tons, and of iron 3 tons. Entire length of bridge, 121 ft.; width, 11 ft. clear, and 17 ft. over all; height of sides, 10 ft.; span, 107 ft.; cost, between £700 and £800.

Tenders are being received for the erection of an *iron bridge over the River Bann.*

A New Bridge has been erected at *Cork* from a design by Sir John Benson, C.E.

A New Bridge for passenger and railway traffic is to be erected at *Londonderry*, from the designs of Mr. John Hawkshaw, C.E., of London.

Chelsea New Iron Bridge is open for traffic.

AGRICULTURAL ENGINEERING, &c.

The Production of Beet-root Sugar has greatly increased in *France.* In December last the number of manufactories at work was 338, being an increase on the preceding year of 56. The quantity of sugar made was 82,451,625 kilos.; being an increase on the preceding season of 28,471,759.

M. Eugene Tisseraud has been nominated *Inspector of Agricultural Establishments* in France.

Dr. Livingstone takes with him to Africa several cases of ploughs and harrows, manufactured by Messrs. John Gray and Co., of Uddingstone.

We received the following from an esteemed correspondent too late for insertion in our last:—"I was yesterday invited by Mr. William Bray, Chief Engineer of the steamer *Lord Warden*, South Eastern Railway Company, to be present at the trial of his Patent Traction Engine for Agricultural Purposes. As it may be interesting to some of your readers to know what is being done in Folkestone in this department of locomotion, with your permission I will make a few remarks on it.

"A tank about 1 ft. deep, 6 ft. wide, and 9 ft. long, forms the foundation or floor, on which lays a tubular boiler—one of Barrans' cup surface 8-horse high-pressure boilers. A neat little pair of horizontal engines are arranged on the side of the boiler, near the top, the crank-shaft working over the fire-box end of the boiler. A pinion on each end of the crank-shaft works into intermediate gearing, and finally into toothed segment wheels bolted on to the driving wheels.

"The driving wheels are the chief novelty—a pair of 8-ft. wheels, constructed of angle and sheet iron, about 12 in. wide. On the face of the wheels are a number of slots, about 1 in. by 6 in. wide. Each of these is fitted with a plate or tooth, so that one or more are embedded in the soil as the wheels revolve. In order to clean the tooth, each of them is attached to an eccentric strap, working on an eccentric fixed to the axle of driving wheels, somewhat like the common arrangement for feathering paddle-wheel floats. The paddle-wheel float moves round its axis partly every revolution of the wheel, while the tooth is put forward and withdrawn every revolution of the wheel. The driving-wheels work loose on the axle. The axle itself is also moveable in its bearings, and provided with set screws to fix it. A wheel and worm shifts it round in its bearings, so as to alter the throw of the eccentric, thereby giving the necessary dip to the tooth, or none, as required.

"The two front wheels are ordinary waggon wheels, about 4 ft. diameter, connected to the tank by a truck fitted with a toothed segment and pinion. The pinion-shaft is upright, mounted with a capstan wheel to steer with; the whole affair occupying about the same space as an ordinary waggon, locking more completely, and turning round in much less space than a waggon.

"The engine, with two hours' supply of coal and water on board, weighs about 5 tons. It had been out the day before, and proved itself almost as handy as a lady's perambulator in the streets and crooked lanes of our town. To-day, the task assigned to it was to climb the Folkestone hill, on the Old Dover-road, a distance of about a mile and a half—a winding road round the face of a hill, with a total ascent of 300 ft.; some parts of the road had a gradient of 1 in 8. I am happy to say it was accomplished to the satisfaction of all present. Two four-wheeled farm waggons were loaded with stones, and weighed in all about 10 tons. These were attached to the engine, which started with about 40 lbs. steam, varying from that to 60 lbs. per inch, that being the highest, and took its load up without any apparent difficulty, in 35 minutes, a distance of a mile and a half, and an ascent of about 300 ft.

"The engine was now disconnected from the load, the pinion shifted into the first motion, and run off about two miles, at the rate of about six miles an hour, and back, much to the astonishment of our country friends.

"The pinion was again shifted on to the slow motion, and preparations made for the descent, which was accomplished as satisfactorily as the ascent. All the waggon wheels were skidded, so that the engine had to use a little steam in the descent also.

"This engine has none of the cumbrous appendage of the endless railway of Boydell's, or the complex maze of appliances in Fowler's, and bids fair to be a more useful auxiliary to the agriculturist than either. Alterations and improvements have suggested themselves in the erection of another engine, yet the simplicity and fewness of parts must convince all who see it that sound judgment, and good common sense, have, at least, been brought to bear on this all-important subject to the farmer."—Onwards.

Boydell's Traction Engine.—A traction-power engine (Boydell's patent) has just been made at Lincoln by Messrs. Clayton and Shuttleworth, by order of Messrs. Crosskill, of Beverley, who are about to send it to Odessa. The machine, says the local paper, has been tried, and its action was perfectly satisfactory. It is constructed on the principle patented by Mr. Boydell, but it varies in some particulars from those we have yet seen. In the first place, it moves on three wheels instead of five; the weight of the boiler resting on two wheels of immense strength: the third, being a steering or guiding wheel, placed at the front, something after the fashion of a perambulator. Behind this wheel is a box for the steersman, who is enabled, by a very simple apparatus, to turn the ponderous vehicle under his guidance in any direction, and with the utmost facility. The average speed at which the engine will travel along good roads is stated to be 3 miles per hour, though the steam power is sufficient to propel it at the rate of 4 miles per hour if necessary. The plan upon which this engine has been constructed is considered to be an improvement on the five-wheeled engines, inasmuch as the locomotion will be less difficult on heavy roads. The machine has been finished with every regard to utility, and no expense has been spared in its manufacture to render it one of the most perfect specimens of the invention yet produced.

There are in France 20,000,000 acres of *uncultivated moors and "landes"* (exclusive of marshes), which, by drainage, might be transformed into pasture land.

BOILERS, FURNACES, SMOKE PREVENTION, &c.

THE BOILER EXPLOSION AT TIVIDALE.

The inquest on three of the four men killed by the explosion of a boiler at the ironworks of Messrs. Whitehead and Haines, at Tividale, near Dudley, was concluded on Monday last, March 12. Mr. Thomas Tertius Chellingworth, civil engineer, of Birmingham, said: I first examined the boilers in question (three) on Saturday, the 27th of February, about an hour and a half after the explosion. I found that there had been three high-pressure boilers placed side by side. The centre or exploded boiler was 4 ft. 8 in. in diameter, by 36 ft. long. It was torn in a longitudinal direction. The ironwork on the boiler was more or less injured. I carefully examined the plates of the exploded boiler, and found they varied from five-sixteenths to three-eighths of an inch in thickness. The rivets were three-quarters of an inch in diameter, and from an inch and seven-eighths to 2 in. apart. The metal was varied in quality, being in some places very good, and in others very bad. At the place where the rent took place, round the boiler is a ring of short plates, only about 6 in. wide. At this place the boiler would appear to have been lengthened, and from this part the metal was of a very different character. There were several patches on the boiler, one where the plate appears to have been burnt. There was also a plate at the bottom of the boiler, near the fireplace, stopping a hole that had apparently once been used for a blowing-off pipe. This patch was in bad condition, and evidently leaked. It was also much corroded, though I do not think that this leak was of itself sufficient to cause shortness of water. The plates presented a dull appearance. They were near the middle. I have no doubt they had been red hot. I arrive at this conclusion from the experiments I have made with portions of the plate. On examining the inside of the plates, I found the scurf cracked and loose, and having the general appearance of having been heated. The outside of the plates were free from soot, which had evidently been burnt off. Had the boiler not been red hot, the soot would have been adhering to the plates. I was there soon after the explosion, and saw a

good deal of water about, but this might, in a great measure, be accounted for by an old water tank near the boilers being shattered by the explosion. I made further examinations on the 2nd, 4th, and 5th inst. The appearance of the plates corroborated my previous opinions. Leighton and Phipps, men in the works, showed me three round cast-iron balls, 9 in. in diameter, and weighing about 105 lbs. each; one 8 in. in diameter, weighing about 70 lbs. The lever of the exploded boiler is 33 in. from the end to the fulcrum, and 4 in. from the fulcrum to the centre of the valve. This would give a pressure of 70 lbs. to the square inch with one of the 9-in. weights upon it, it being a 4-in. valve. The lever of the left-hand boiler is 44 in. from end to fulcrum, and 4 in. from fulcrum to centre of valve. This valve was 5 in. in diameter, and with a 9-in. weight would give a pressure of 60 lbs. per square inch. There were two 5-in. safety-valves with 9-in. weights on the boiler next the canal; one 4-in. valve with 9-in. weight on centre (exploded) boiler; and a 4-in. valve with 8-in. weight on left-hand boiler. There were two buoys on the exploded boiler—one near the centre, and another at the end farthest from the fire. There were two buoys on the left-hand boiler, and there appears to have been one buoy on the outside boiler. The three boilers had to supply steam to two high-pressure engines; the smaller one driving the hammer, and the larger one the rolling mill. The large engine has a 22 in. cylinder, and 3 ft. 9 in. stroke, and makes about twenty-six strokes per minute. With 60 lbs. of steam this would give 93 effective H.P. The small engine, having a cylinder of 17 in. in diameter, has a 2 ft. 6 in. stroke, and makes forty revolutions. The two engines would give an effective power of 150 horse. The heating surface of three boilers was 844 superficial feet, and, allowing 9 ft. to every H.P., it would give 94 effective H.P. of heating surface. This causes a deficiency in the heating surface of the boilers, compared with the power the engines are worked up to, of 62 horse. I think at the time of the explosion there would not have been less than 100 lbs. per square inch of pressure, although the safety-valve was only weighted at 70 lbs., if there was no other weight on than the ball, because when the engines stopped for want of steam there was in all probability very little water in the boiler. The firing being continued, and the steam having no vent but by the safety-valve, the steam would continue to increase in pressure, and this would be further assisted by the agitation of the water caused by the steam passing away through the valve. The water coming in contact with heated plates would generate steam much faster than it was possible for the valve to carry it away. I believe that the explosion occurred through the boilers being worked to too high a pressure, and from shortness of water in the exploded boiler at the time of the accident. I also believe the boilers had been subjected to very hard firing, necessitated by their not being of sufficient capacity for the power the engines were worked to; and also that the exploded boiler was partly red hot at the time of the accident. One portion of the boiler appears very much worn, and the other part—where it has been lengthened—in very good condition. I am of opinion, from the appearance, that it has been red hot before. I can't say how many times. From the state the boiler was in, I should think it was not safe to work it at more than 35 lbs. to 40 lbs. at most per square in. I cannot say what pressure the boiler was working at at the time; but I should think from the *débris* at something more than 100 lbs. on the square inch. A boiler in a good condition, of that thickness and dimensions, would work safely at 60 lbs. There was, in fact, more work to be done than the engines were capable of performing

Isaiah Cartwright, of Tividale, engineer, said, from an examination of the plates on Saturday last, he believed they were hot at the time of the explosion.

Mr. George Smith, consulting engineer, of the Wellington Road, Dudley, said he agreed with the evidence of Mr. Chellingworth as to the position and size of the boilers. He found no plates under three-eighths of an inch thick. It appeared to him that there was plenty of water in the boiler at the time of the explosion, as the scurf was still on the plates. He did not, therefore, believe that the plates where red hot. They were hot of course. The boiler had two patches in it, but he considered that generally it was in good working order. The boiler would, in his opinion, be perfectly safe to work at 60 lbs. pressure on the square inch.

The jury returned the following verdict:—"That the deceased were killed by the explosion of the boiler, which explosion was caused by an undue pressure of steam, but that there was no evidence before the jury to show the cause of such pressure."

BOILER EXPLOSION.—BANBURY, MARCH 2.

A fearful explosion through the bursting of a boiler took place in Banbury on Tuesday at mid-day; but we are happy to add the damage done, which is very considerable, was only to property, and not to life. The large worsted mills of the Messrs. Baughen, at the foot of Factory-street, have not been in operation for the last six months, but in order to keep the valuable machinery in working condition the various rooms have been kept heated when necessary. For this purpose a small tubular boiler, 4 ft. 2 in. long by about 2 ft. in diameter, has been employed to generate steam and heat water, which was led over the premises in small iron pipes. This boiler was built in the wool-washing room, a one-story house, abutting on the north side of the main building and on the east wall of the wool-sorters' room. During two or three days prior to the accident the boiler had not been used, and it now appears that the water had become frozen in the pipes, thus closing up the usual exit for the contents of the boiler. Not aware of that fact, the attendant lighted the fire in the boiler on Tuesday morning about 9 o'clock, which was kept up, and at a quarter to 12 he added some fresh fuel, and then went home to dinner. He had only got to the White Horse Hotel when he heard a tremendous explosion, which shook the ground in the circuit of some hundreds of yards from the detonating centre. It was soon found that the violent concussion in the air which ensued was caused by the sudden rupture of all the outside plates of the boiler, which were thrown in different directions, some a distance of ten yards, the boiler itself weighing at least a ton, breaking down the house it was in, it being propelled about ten or twelve yards from its former bed. Heavy planks, ladders, and bricks also were projected like pebbles to considerable distances, a brick-bat breaking in a window-sash in Messrs. Cobb's girth-weaving factory, and passing very close to the manager's (Mr. Taylor's) head. The damage done to property is very considerable, as already stated. The wool-washing room is completely demolished, and a washing-machine in it was partially broken. One part of the wall of the wool-sorters' room is blown down, and certain furniture in it destroyed, while the roof is greatly damaged. A small office, at the distance of about twelve yards, the door of which was locked, was made the receptacle of part of one of the walls of the washing-room, the door being blown open and broken, and a fixed ladder leading to the top story was knocked down. A hole has been made in the roof of the main building from something falling upon it, although it is at least 50 or 60 feet high; the roof of this and the adjoining buildings are more or less injured. A carding engine on the ground-floor of the mill was broken also, and at least 500 panes of glass have been broken in the houses within twenty yards of the scene of the explosion. In some cases the sashes wore blown in, and in some instances blown out of the same room. Some doors likewise have been broken in a curious way, and, apparently, only by the violent concussion of the air.—*Banbury Guardian.*

SERIOUS BOILER EXPLOSION.—A boiler explosion occurred on board the North of Europe Steam Navigation Company's steamer, *St. George*, scalding the master, Captain N. R. Sayers, and the chief engineer, Mr. J. Surtees, so frightfully, that both expired within a few hours afterwards. Before leaving Sierra Leone, a survey was made by the chief engineer of Her Majesty's ship *Conflict*, and the chief engineer of the *Oscar* steamer, "who certified that both engines and boilers were in a sufficient condition to proceed to sea for one month, with care particularly to the boiler." On the morning of the 6th, one of the firemen, while preparing the furnaces, noticed that the crown of the starboard furnace had sunk to the bars, and was more than usually low. He immediately warned his mate of the danger. The chief engineer, Mr. Surtees, saw the crown of the boiler, and was of the same opinion, and told the captain so. The captain replied, that he wanted steam only for twenty-four hours more, and pressed the chief engineer to keep it on if possible. The chief engineer again examined it, and called the captain into the stoke-hole to satisfy him that it was not safe. They were both looking at it when the crown of the boiler gave way, and completely immersed both of them in scalding water, and two of the firemen who were also below. The engineer is stated to have been overruled by the captain with regard to the working of the boiler.

BOILER EXPLOSION.—Another of these terrible events too common in the mining and iron districts around Dudley, Worcestershire, occurred a few days ago at the works of Messrs. Whitehead and Harris, when three men were killed and others were maimed for life. The inquest on the bodies, after an adjournment, has just been concluded before Mr. Hinchliffe, coroner for the district. The boiler has been carefully examined since the explosion, and evidence was given by Mr. Chillingworth, of Birmingham, and Mr. J. P. Cartwright, to the effect that the boiler had been overworked, and had been red hot from want of water. A third engineer, however, Mr. G. Smith, of Dudley, was of opinion that the plates of the boiler had not been red hot, although the explosion took place from over pressure. The boiler had been repaired last Christmas. The jury returned the following verdict:—"That the deceased were killed by the explosion, which explosion was caused by an undue pressure of steam; but there was no evidence to show the cause of such pressure."

BOILER EXPLOSION.—One of the boilers connected with the large chain and cable works of Messrs. N. Hingeley and Sons, Netherton, has exploded, and the explosion, though fortunately unattended with any loss of life, has resulted in damages to the works estimated at between £200 and £300. The boiler is one of cylindrical shape, about 35 ft. in length, and 6 ft. in diameter, and weighs upwards of 13 tons. It was of the description known as tubular, and had a tube through its centre of about 3 ft. 6 in. in diameter. It was used, in conjunction with another boiler, for the purpose of driving steam hammers, and supplying blast to the adjoining chain and anchor works. It was calculated to bear about 120 lbs. to the square inch, and is said to have been at work on the day in question at about 63 lbs., the ordinary pressure. While the work was proceeding as usual the explosion, without a moment's intimation that anything was wrong, took place. On examination, it was found that the fractured plates were at the top part of the tube, and about 10 ft. from the firing end, where a rent about 6 ft. long and 3 ft. wide had been made. The boiler itself, which was imbedded in a thick mass of brickwork, was displaced to the extent of about 14 in. forward, but had apparently sustained no further injury than that described. The force of the explosion seemed to have taken a direction towards the back end of the boiler, for a mass of brickwork, 7 ft. thick and 6 ft. or 8 ft. wide, which stood between it and the fan and engine-house, was forced away, and both the latter entirely demolished; a great deal of the machinery being, as a necessary consequence, very seriously damaged. The boiler was new about ten months ago.

ONE of the boilers supplying a workshop engine at the works of Messrs. Palmer, of Jarrow, has exploded; one life lost.

THE CONSUMPTION OF SMOKE.—A Manufacturers' Defence Association has been formed for the Metropolis.

EXPERIMENTS have been carried out for some time past in the manufacturing department of the Royal Arsenal, Woolwich, with a view of ascertaining the best description of smoke-consuming furnaces for use in the Government establishments, for welding or melting iron, and so as to comply with the provisions of Lord Palmerston's Act. The plans of Mr. Armstrong and Major Vandeleur, R.A., have, during the past fortnight, been tested in a competitive form in the Royal gun factories. Two furnaces of equal dimensions were fitted up, under the directions of these gentlemen, and employed on similar work, namely, forging double-heated blooms from scrap iron. As regards the consumption of smoke, they appeared to be equally efficient; but the result in other respects has hitherto been in favour of the latter. The coals consumed and work done during the ordinary working week of 56 hours were:—

	Coals consumed.		Blooms made.	
	Tons.	Cwt.	Tons.	Cwt.
Mr. Armstrong's	10	10	4	14
Furnace in ordinary use	9	0	4	10
Mr. Vandeleur's	8	10	5	10

The intensity of the heat attained in the last was also very remarkable. The heating of masses of iron which usually requires from 40 to 50 minutes, was occasionally accomplished in 20, and seldom exceeded 30 minutes. The trials are to be continued.

INCRUSTATION IN STEAM BOILERS.—According to Cosmos, M. Odruay avails himself of a frosty day, opening the man-hole door, empties the boiler, and wets the inside of it with common water. This water is frozen during the night, and, in passing from the liquid to the solid state, its molecules break up and detach the incrustations. M. Odruay is said to have employed this plan constantly for ten years.

CONSUMPTION OF SMOKE ON BOARD STEAMERS. — The Directors of the Shields steam ferries, and the whole of the owners of the steam tug on the Tyne, have received notice from the river authorities that they have to adopt measures for the consumption of smoke emitted by their respective vessels. The owners of steam tugs have made a considerable demur with regard to acting on the notices served upon them; but we understand they are consulting with Mr. J. W. Armstrong as to the practicability of consuming the smoke on board those vessels. We understand that Mr. W. Reed, C.E., of Newcastle, is engaged fitting up an apparatus on board the *Northumberland* steam ferry for the consumption of smoke.

APPLIED CHEMISTRY, &c.

ARTIFICIAL MANUFACTURE OF COAL.—At the last meeting of the Academy of Sciences, Paris, M. de Séuarmont gave an account of recent experiments on the artificial manufacture of coal, made by M. Barhouilhet, at St. Etienne. M. Cagniard de Latour had previously submitted woody matters, in closed vessels, to the action of great heat, with the view of obtaining coal, but the only result was bitumen. M. Barhouilhet has repeated these experiments, but with two important modifications. Firstly, he interposes a stratum of woody matter between layers of clay; secondly, the vessel is not completely closed, but so arranged that the disengaged gas remains a certain time in contact with the mixture of ligneous matter and clay. The temperature to which the mixture was submitted did not generally exceed 392° Fahr. The products resemble coal in every respect, and their appearance varied according to the nature of the wood used, and also with the temperature. Leaves interposed between the strata, left their impression on the coal; these are a little broken on account of the leaves being fresh and soft. Dry leaves would doubtless have given impressions resembling those of nature.

BLACK PIGMENT FROM SCHIST.—M. Mareschal has obtained from schist a very solid and brilliant black, absorbing less oil, covering better, and flowing more easy from the brush. That schist is used from which the oil has been extracted. It is powdered and sifted until it is brought to a state of impalpable powder. The powder is then washed and dried by heat.

LUBRICATING MATERIAL.—M. Rohrig has succeeded in removing the acid principles of fat, and thus obtained a new lubricating material. For greasing machinery this substance is said to be preferable to common olive oil, and also to neat's foot oil; it oxidizes the metals less, and hardly colours copper, bronze, or brass. It does not run, and it is procurable at a cheap rate.

MESSRS. CALVERT AND LOW have succeeded in obtaining from coal-tar products having a most extraordinary dyeing power, and yielding colours nearly as beautiful as safflower, pinks, and cochineal crimsons; and what increases the interest of this coal-tar

product is, that by the process discovered, they can obtain with it, on a piece of calico mordanted for madder colours, all the various colours and shades given by this valuable root,—violet, purple, chocolate, pink, and red.

MINES, METALLURGY, &c.

COAL BEDS.—Fourteen seams have been laid open on the estate of Lord Fielding, called Bychlon, on the borders of the Dee. According to the reports of the engineers, it will take 100 years to exhaust this place at the rate of 2,500 tons per week. Sixty beds of the best quality of iron ore have also been discovered on the same estate.

IT is reported that gold has been discovered about eight miles from St. John's, New Brunswick, on the Carleton side of the river.

AN important lead mine discovery has been made at Galena, U.S., by an Englishman named Mills.

A GOLD FIELD has been found at *King George's Sound*, Western Australia.

IMPROVEMENTS IN THE VOLTAIC PILE.—Bunsen's pile has two defects, it emits nitrous vapours, and the electric current, though strong at first, rapidly decreases in intensity. Bunsen was aware of this, and substituted bichromate of potash for the nitric acid, and Puggendorff subsequently suggested the addition of sulphuric acid to the bichromate; but though the exhalation of nitrous vapour was avoided, the diminution of intensity was, as before, owing to a deposit of oxide of chromium, with which the charcoal and zinc of the voltaic couple became rapidly coated in the course of the operation. M. Grenet has been fortunate enough to prevent the formation of the oxide, by the curious expedient of making a strong current of air pass through the pile. This current causes the oxide of chromium to be re-dissolved in the exciting liquid as soon as it is formed, the elements of the pile remain unencumbered, and the voltaic current retains the same degree of intensity. M. Grenet's pile consists of plates of zinc and charcoal placed alternately in a frame provided with vertical grooves, into which they fit, so that, as usual, the plates are separated from each other by interstices The zinc plates are all attached to a copper wire acting as a conductor; another conductor, of the same material, connects together all the plates of charcoal. These conductors are coated with an insulating substance. The frame has a hollow bottom pierced with small holes corresponding to the interstices, and a lateral tube fixed to this bottom communicates with the nozzle of a ventilator. The exciting liquid contained in a metal trough, consists of a saturated solution of bicarbonate of potash, acidulated with about one-hundreth part of sulphuric acid. When the pile is to be used, the rame, with the couples which fits into the trough, is immersed in the liquid and the ventilator set agoing. As no deposit is formed, the liquid may be kept a considerable time without it being necessary to renew it; or it may be partially renewed from time to time, the great object to be kept in view being, first, the perfect saturation of the liquid, and, secondly, the permanent insufflation of air while the pile is being used.

NOTICES TO CORRESPONDENTS.

R. C. P.—The following is the extract from "Earnshaw's Dynamics," which we give in full, instead of merely referring to the articles. You will see how far it applies to the case referred to. We also give the title, &c., of the work, which is now difficult to obtain.

Dynamics; or, an Elementary Treatise on Motion. By S. Earnshaw, B.A., St. John's, Cambridge, 1832. Metcalf and Deighton, Cambridge; Whittaker and Co., London.

138. Let m be one of the particles of a system of bodies. Then if to the forces which are impressed upon m we add those which it suffers from the action of the other parts of the system, we may consider it as free. Let X Y Z be the moving forces, so estimated, acting upon it, resolved in directions of the co-ordinates. Then

$$m \,.\, d_t^2 x = \mathrm{X},\ m \,.\, d_t^2 y = \mathrm{Y},\ m \,.\, d_t^2 z = \mathrm{Z}.$$

$$\therefore\ m\,(d_t x^2 + d_t y^2 + d_t z^2) = \mathrm{C} + 2\int(\mathrm{X}\,dx + \mathrm{Y}\,dy + \mathrm{Z}\,dz);$$

or, putting v for the velocity of m,

$$\Sigma\,(m\,v^2) = \mathrm{C} + 2\int(\mathrm{X}\,dx + \mathrm{Y}\,dy + \mathrm{Z}\,dz).$$

Now if $\mathrm{X}\,dx + \mathrm{Y}\,dy + \mathrm{Z}\,dz$ be an exact differential of a function of three variables, we have

$$\Sigma\,(m\,v^2) = \mathrm{C} + 2\,\Sigma\,\phi\,(x, y, z).$$

This equation is similar to the one we have already found in Art. 82, and leads to similar results:—That if the system be not acted on by any forces, its *vis viva* is constant; that, in other cases, the increment or decrement of its *vis viva*, in passing from one position to another, is independent of the paths described by its different particles, and is, therefore, the same as if the particles were free; that this increment or decrement is evanescent every time the system returns to the same position.

It appears, from the preceding chapters, that the same is true if the particles be unconnected and attract each other, or be attracted to a fixed centre, or to the centre of gravity of the system, which comprehend all the forces which are found in Nature. See Arts. 59, 63, 82, 111, 129.

139. The principle of *vis viva* is not true if any of the bodies move in a resisting medium, or be affected by friction; for then $\Sigma\,(\mathrm{X}\,dx + \mathrm{Y}\,dy + \mathrm{Z}\,dz)$ is not a complete differential. And of this we may also be assured, by considering that either of these causes tends continually to diminish the velocity, and $\therefore$ the *vis viva*; and, supposing the system acted on by no other forces, would at length reduce it to a state of rest; whereas, according to the general principle, the *vis viva* ought to be constant.

If any of the bodies happen to impinge upon each other, the *vis viva* (unless they are perfectly elastic) will be suddenly diminished. (Art. 33.)

140. If a body (or system of rigidly connected particles) move in any manner whatever, its *vis viva* at any instant = the *vis viva* of the whole mass collected at the centre of gravity + the *vis viva* round the centre of gravity; or, in other words, the *vis viva* of body = the *vis viva* from translation + the *vis viva* from rotation.

For let $\dot{x}\,\dot{y}\,\dot{z}$ be co-ordinates of the centre of gravity of the system, the axis of y being $\parallel$ to the axis of rotation round the centre of gravity; r = distance of any particle m from that axis; $\theta = \angle$ which r makes with plane $x\,y$.

$$\therefore\ x = \dot{x} + r\cos\theta,\ z = \dot{z} + r,\ \sin\theta,\ \text{and}\ d_t y = d_t \dot{y},$$

and (vel.)^2 of the particle =

$$d_t x^2 + d_t y^2 + d_t z^2 = (d_t \dot{x} - \sin\theta \,.\, d_t\theta)^2 + d_t \dot{y}^2 + \left(d_t \dot{z} + r\cos\theta \,.\, d_t\theta\right)^2 = d_t \dot{x}$$
$$+\, d_t \dot{y}^2 + d_t \dot{z}^2 + r^2 d_t \theta^2 - 2\,d_t \dot{x} \,.\, d_t\theta \,.\, r\sin\theta + 2\,d_t \dot{z} \,.\, d_t\theta \,.\, r\cos\theta.$$

Now $\Sigma\,(m\,.\,r\sin\theta) = 0$, $\Sigma\,(m\,.\,r\cos\theta) = 0$, and

$\therefore$ the *vis viva* $= \Sigma m\,(d_t \dot{x}^2 + d_t \dot{y}^2 + d_t \dot{z}^2) + \Sigma m\,(r\,d_t\,\theta)^2$,

= the *vis viva* from translation + the *vis viva* from rotation.

COR. The *vis viva* from rotation $= \Sigma m r^2 d_t \theta^2 = d_t \theta^2\,\Sigma m r^2$ = the moment of inertia multiplied by the square of the angular velocity.

141. When a system passes through a position of equilibrium its *vis viva* will be a maximum or minimum.

By D'Alembert's principle, the effective forces are always such as would, when applied in opposite directions to those in which they act, balance the impressed forces; and here the latter would produce equilibrium, and $\therefore$ the former are such as would also, in the samo position of the system, produce equilibrium.

Let v = the velocity of one of the particles m; $\therefore$ the effective force on m is $m\,d_t\,v$, and since there is an equilibrium among the affective forces, by virtual velocities,* $\Sigma\,(m\,v\,d_t\,v) = 0$

$\therefore$ $\Sigma\,(m\,v^2)$ is a maximum or minimum.

142. COR. If the position be one of *stable* equilibrium, when the system passes out of that position, the tendency of the impressed forces will be to bring it back to it again; $\therefore$ they will diminish both the $\angle^r$ velocity (for by $\angle^r$ motion the body is carried from that position) and the velocity of translation; and $\therefore$ the *vis viva*, which = *vis viva* from rotation + that from translation, will be diminished. And, by similar reasoning, if the position be one of *unstable* equilibrium, the *vis viva* will be increased; but if of *neuter* equilibrium, it will neither be increased nor diminished. Hence, the *vis viva* will be a *maximum*, *minimum*, or *neither*, according as the position is one of *stable*, *unstable*, or *neuter* equilibrium.

R.—Not for two or three months.

W. C.—An abstract of discussion upon Longridge, and Brook's, and Webb's papers, read before the Institution of Civil Engineers, will be given with the abstracts of the two papers in our next. Although present at each of the meetings, we cannot publish any but the authorised report thereof, which will be forwarded to us in due course.

S. C. (Cardiff).—We will endeavour to comply with your request shortly.

J. R. H.—Employ your time in something more sensible, and keep your money in your pocket: there are other quacks than those who post their advertisements in urinals, or publish books addressed to the green and gullible of the male sex.

R. C. G. (Brighton).—Send to Newton's, Fleet-street; Wood's, Cheapside; or Horne and Co., Newgate-street. As to the other instruments, apply to Fenn, Newgate-street.

D. D. (Lisbon)—The information will be obtained by the 3rd or 4th, and will be sent through Portuguese Legation.

NOTICE.

SEVERAL REVIEWS AND NOTICES OF NEW BOOKS are, from necessity, omitted this month, but will be given next month.

CORRESPONDENTS whose letters are not acknowledged through post, or to whom replies are not given in this month's Number, will receive them in our next.

* For a demonstration of the Statical principle of virtual velocities, the reader is referred to "Pritchard's Statical Couples," *Appendix, Prop. D.*

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 5th January, 1858.

17. J. Platt, Oldham—Machinery for spinning and doubling or twining cotton and other fibrous materials.

Dated 20th January, 1858.

98. C. Davage and T. Davage, Sheffield—Railway crossings.

Dated 21st January, 1858.

108. J. J. Robinson, Fratton, near Portsea—Apparatus for sorting and stamping letters, books, newspapers, and other articles.

Dated 28th January, 1858.

152. P. Bussi, 38, Cannon-street—Railway carriage.

Dated 29th January 1858.

161. E. Hammond, Nos. 90 and 91, Herbert-street, Hoxton—Manufacture of cap fronts, and applicable to the manufacture of ruches, ribbon trimmings, and other articles of millinery.

Dated 1st February, 1858.

177. T. Heppleston, Manchester—Apparatus for doubling, twisting, and reeling yarns or threads.
179. J. A. Manning, Inner Temple—Manure.
181. J. Childs, Belmont, Vauxhall—Manufacture of the boxes or cases used for night lights.
183. J. Haste, New Dock Works, Leeds—Apparatus for preventing the explosion of steam boilers.
185. R. A. Brooman, 166, Fleet-street—Sewing machines.

15

Dated 2nd February, 1858.

187. W. C. Holmes and W. Hollinshead, Huddersfield—Manufacture of gas, and apparatus employed therein.
189. W. E. Newton, 66, Chancery-lane—Instrument for sharpening the blades of knives.
191. W. Westley, Birmingham—Construction of heels for boots and shoes.
192. J. Gray, Bonally Tower, Colinton, near Edinburgh—Printing machinery.

Dated 3rd February, 1858.

193. E. Moss, Manchester—Weighing cranes.
194. J. Morris, Red House, Great Bridge, Staffordshire—Improvements in boots and shoes.
195. A. Hollis and S. Lee, Darlington—Construction of chaldron-waggon and other railway wheels.
196. A. N. Armani, Haverstock-hill—Rail or tramways for streets and ordinary roads.
197. E. F. Dillage, 14 Boulevart Poissonniere, Paris, Franee—Apparatus for raising, forcing, and exhausting fluids, air, and gases.
198. W. E. Newton, 66, Chancery-lane—Apparatus for raising and lowering the skirts of ladies' dresses.
199. L. S. de la Magdeleine, Paris, France—Manure.
201. W. Longley, Erith, Kent—Apparatus for grinding and splitting grain.
202. W. Clark, 53, Chancery-lane—Hydraulic apparatus for obtaining motive power.

Dated 4th February, 1858.

203. J. Harrison, Brailsford, Derbyshire—Apparatus for making cheese.
204. R. Harland, Derby—Brake lever guard of railway trucks.
205. D. Smithies, Manchester—Manufacture of healds or harness for weaving.
206. B. Beale, Greenwich—Apparatus for paying out and drawing in electric telegraph cables, applicable also to the raising and lowering of weights.
207. J. Avery, 32, Essex-street, Strand—Improvement in mechanical movements for sewing and other machines.
208. D. Williams, Tredegar, Monmouthshire—Construction of ovens or furnaces for the manufacture of coke, and in the means of emptying or discharging the same.
209. G. Bertram, Edinburgh, and W. McNiven, Polton Mill, Lasswade—Manufacture of paper.
210. C. Knight, St. John's-wood—Railway guide.
211. J. Goodman and L. Goodman, Finsbury-street, Finsbury-square—Portable umbrella.
212. W. Rhodes, Manchester, and H. Napier, Brooklyn New York—Production of a "new paint oil."

Dated 5th February, 1858.

213. A. Crichton and M. Whitehill, Paisley, Renfrew, N.B.—Application, adaptation, and use of knitted fabrics.

214. E. Collingwood and T. Collingwood, Rochdale—Machinery for propelling vessels on water.
215. A. Woodward and W. C. S. Percy, Manchester—Apparatus for raising and lowering weights, designed as a provision against accidents, to which such apparatus or machinery is liable.
216. J. Welch, Southall—Railway and other carriage brakes.
217. Sir C. Shaw, Chapel-place, Cavendish-square—Constructing moveable or field batteries.
218. S. Williamson, Hanover-street, Cork—Construction and mode of affixing street and other gas lamps or lanterns.
219. S. Dyer, Bristol—Method of reefing, furling, and securing all the sails of ships or vessels.

Dated 6th February, 1858.

222. W. Potts, Handsworth, Staffordshire—Painting upon glass, and in protecting paintings upon glass.
223. G. Davies, 1, Serle-street, Lincoln's-inn—Improvements in the preservation of meat and other animal and also vegetable substances.
224. W. White and J. Parlby, Great Marylebone-street—Preparation or treatment of carton-pierre, papier mâché, and such like plastic substances, and in the application of such matters to walls, ceilings, and other internal parts of buildings, berths, and other parts of ships and other vessels, carriages, and other structures.
225. W. Ball, Rothwell, near Kettering, Northamptonshire—Ploughs.
226. J. Miller, Upper George-street, Edgware-road—Manufacture of bread.

Dated 8th February, 1858.

227. R. Wilson, Liverpool—Propelling navigable vessels.
228. F. Mathieu, Lawrence-lane—Stereoscopes.
229. J. D. Tripe, Commercial-road—Apparatus for securing window sashes or casements.
230. P. S. Meroux, St. Denis, France—Improvements in fire bars and grates for furnaces and other fireplaces.
231. R. Cunningham, Paisley, Renfrew, N.B.—Improvements in or connected with the production of letterpress printing surfaces, and surfaces used in reproducing ornamental patterns or devices by printing or otherwise.
232. E. Dench, Chelsea—Boiler for heating water for heating and warming.
233. R. W. Johnson and W. Stableford, Oldbury, Worcestershire—Brake levers of railway waggons.
234. W. E. Newton, 66, Chancery-lane—Apparatus for breaking stones, minerals, and other analagous substances.
235. H. Ball, Birmingham—Improvements in repeating and other fire-arms, a portion of which improvements may be applied to ordnance.
236. E. Reader and J. Dewick, Finkhill-street, Nottingham—Lace machinery for the manufacture of velvet lace and looped fabrics, and in the fabrics manufactured by such machinery.

Dated 9th February, 1858.

237. C. Askew, 27½, Charles-street, Hampstead-road, and D. Ritchie, 42, William-street, Regent's-park—Roasting machine for meat, poultry, or game of any kind, to be worked by spring-jack movements, or by the ordinary smoke jack.
238. J. Wells, Percival-street, Clerkenwell—Watch cases.
239. W. Brown and C. N. Day, Devizes—Sluice valves.
242. E. Leigh, Manchester—Carding engines for carding fibrous materials.
243. J. Taylor, Swanton Novers, Thetford—Construction of horse hoes and drills.
244. B. B. Wells, 431, Strand—Apparatus for counting and indicating numbers.
245. R. Carte, 20, Charing-cross—Clarinets.
246. E. Stevens, Cambridge-road—Machinery for preparing dough, paste, and like articles.

Dated 10th February, 1858.

247. G. Richardson, 2, Copenhagen street, Islington, and W. Richardson, 5, Ranelagh-grove, Pimlico—Three-wheeled carriages, and omnibuses so constructed as to be called first-class omnibuses.
249. G. J. Ping, Chard, Somerset—Machinery for the manufacture of bobbin net and netted fabrics.
250. R. Aytoun, Edinburgh—Safety cages or apparatus for mines.
251. W. Palmer, Sutton-street, Clerkenwell—Lamps.
252. J. Chatterton, Devonshire-street, Islington—Electric telegraph wires, and insulating telegraph wires.
253. J. Nasmyth, Lille, France—Mode of obtaining motive power and of applying it.

Dated 11th February, 1858.

254. A. Chambers, Canterbury, and W. H. Champion, Lynsted, Kent—Railway brakes.
255. L. Cass, Bury—Steam engines and steam engine boilers.
256. R. Bell, Gracechurch-street—Stable pans, sinks, and urinals.
257. G. A. Barrett, W. Exall, and C. J. Andrewes, Reading—Manufacture of perforated beaters for thrashing machines.
258. B. Looker, jun., Kingston-on-Thames—Sockets for receiving telegraphic and other posts or uprights.
260. G. W. Burton, Dubuque, Iowa, U.S.—Method of manufacturing white lead.
261. J. R. W. Atkinson, Leeds—Mode of tightening up and unscrewing binding nuts and screws.
262. W. Keatinge, Merrion-square, Dublin—Correcting variations in the mariner's compass from local attraction.
263. G. Thorrington, Old Windsor—Method of propulsion, applicable to agricultural purposes.

Dated 12th February, 1858.

264. W. N. Wilson, 144, High Holborn—Machines for cleaning and polishing knives.
265. W. N. Wilson, 144, High Holborn—Washing and wringing machines.
266. J. C. Fisher and J. Booth, Blackburn—Mode or method of driving mule spindles.
267. J. Horsey, Greek-street—India rubber and elastic band or ring fastenings.
268. J. Clifton, New Oxford-street—Nursery furniture or gymnastic exercising chair and support for children.
269. T. Neville, Lichfield, and W. S. Dorsett, Aldridge, near Walsall—Steam boilers or steam generators, and in steam engines.
270. T. Neville, Lichfield, and W. S. Dorsett, Aldridge, near Walsall—Method of constructing and actuating horizontal water wheels.
271. A. V. Newton, 66, Chancery-lane—Construction of sewing machine.
272. A. V. Newton, 66, Chancery-lane—Machinery for stitching or working button-holes.
273. W. C. T. Schaeffer, Stanningley, near Leeds—Obtaining fatty and oily matters from wash waters, or waters containing soap.
274. J. Macintosh, North Bank, Regent's-park—Treating articles of gutta percha made or formed in dies or moulds, also certain articles of gutta percha made by expressing through dies, and also articles of gutta percha made by pressing rollers.

Dated 13th February, 1858.

276. J. E. Ryffel, Wimbledon—The improvement of stoves, for the purpose of warming rooms and baking bread, called the "hygean stove."
277. J. C. H. Sievier, Upper Holloway—Submarine conductors of electric telegraphs.
278. E. D. Johnson, Wilmington-square—Construction of chronometer case.

Dated 15th February, 1858.

279. W. Spence, 50, Chancery-lane—Telegraphic apparatus.
280. J. McDermid and J. McDermid, Oak Tree, Middleton-one-row, near Darlington—Apparatus or contrivance for supplying water to buildings and dwelling-houses for sanitary purposes, and for the extinction of fire.
281. P. M. N. Benoit, Paris—Counterbalancing the pressure exerted by the steam against the slide-valves of steam engines of all kinds.
282. E. Hunt, Walnut-tree-walk, Lambeth—Voltaic batteries, and in means for producing the electric light.
283. G. T. Bousfield, Loughborough-park, Brixton—Preparation of dough for bread, pastry, cake, and other farinaceous articles of food.
284. P. Molinari, Marseilles, France—Composition, to be used externally, for preventing sea-sickness.
285. J. Tall, 150, Blackfriars-road—Perambulators.
286. M. Crawford, Elswick Iron Works, Newcastle-on-Tyne—Manufacture of furnace bars.
287. G. L. Blyth, Derby-street, Parliament-street—Manufacture of manure from sewage waters and other fluids containing ammonia or nitrogenous matters.
288. W. Cope, Nottingham—Manufacture of fabrics by bobbin-net or twist-lace machinery.
289. H. J. Sanders and S. Thacker, Nottingham—Machinery for the manufacture of textile and looped fabrics.
290. W. E. Newton, 66, Chancery-lane—Treating certain oils and fats, so as to effect the separation of constituent parts of such oils and fats.
291. J. Garnett, Otley—Paper.

Dated 16th February, 1858.

293. H. Wilde, Manchester—Connecting the ends of lightning conductors, and also the ends of submarine electric telegraph cables.
294. W. Armitage, Manchester—Looms.
295. T. B. Daft, Liverpool—Instruments for rubbing out pencil marks and for sharpening pencils.
296. M. A. F. Mennons, 4, South-street, Finsbury—Voltaic batteries.
297. A. V. Newton, 66, Chancery-lane—Apparatus for laying submarine telegraph cables.

Dated 17th February, 1858.

300. J. E. Boyd, Hither-green, Lewisham—Lawn and grass mowing machines.
301. G. Baker and J. E. Baker, Birmingham—Improved machinery for compressing and moulding powders and pastes.
302. P. Heyns, 2, Wade's-place, Poplar—Wheels and axle-boxes.
303. R. Varvill, Manchester—Apparatus for washing clothes or articles of wearing apparel.
304. W. Riddle, 4, Stonefield-terrace, Liverpool-road—Apparatus for binding and fastening bales and other articles.
305. The Hon. W. H. Yelverton, Whitland Abbey, Carmarthenshire, and Owen Bowen, Great Queen-street, Westminster—Manufacture of coke.

Dated 18th February, 1858.

307. E. Cuvelier, Arras, France—Steam engines.
309. W. E. Newton, 66, Chancery-lane—Optical instrument, "Tropescope."
311. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for making bolts and rivets.
313. H. Blair, Kearsley, Lancashire—Recovering the sulphur which has been used in the manufacture of soda ash, and in the apparatus.

Dated 19th February, 1858.

315. J. Beattie, Lawn-place, South Lambeth—Locomotive and other steam engines.
317. J. Syers, Liverpool—Improvements in the decomposition of salt, and in the abstracting of metals from their ores.
319. R. Griffiths, 69, Mornington-road, Regent's-park—Screw propellers, and apparatus for governing engines used to give motion to screw propellers.
321. T. Brazenor, sen., and G. Brazenor, jun., Birmingham—Mill-bands.
323. J. E. Cook, Greenock—Binnacles for marine compasses.
325. W. Clark, 53, Chancery-lane—Filtering water.

Dated 20th February, 1858.

327. R. Little, Glasgow—Machinery for washing and mangling.
329. W. Thomson, Glasgow—Testing and working electric telegraphs.
331. G. Gentile, 41A, Queen-street, Cheapside—Ornamenting lace, netted, knitted, and woven fabrics.
333. F. M. Badouin, Paris—Electric telegraph cables.
335. H. R. Rimels, Brussels—Manufacturing potato meal or fecula.
337. W. Clark, 53, Chancery-lane—Rotary engine.
339. G. Catlin, Brussels—Construction and propelling of steamers.

Dated 22nd February, 1858.

341. G. Schaub, Birmingham—Printing type and other printing surfaces.
343. W. Cory, jun., Gordon-place, Gordon-square—Artificial fuel
345. R. A. Brooman, 166, Fleet-street—Treating ore of precious metals.
347. J. Potts, 24, Park-street, Southwark—Machinery for cutting and shaping toothed gearing.

Dated 23rd February, 1858.

349. R. Telford and M. Hope, Birmingham—Castors for furniture.
351. W. McLennan, Glasgow—Manufacture of boots and shoes.
353. E. Shepard, Jermyn-street, St. James—Depositing metals and metallic alloys by electricity.
355. G. F. White—Mark-lane—Doors and other locks.
357. W. E. Newton, 66, Chancery-lane—Process for producing photographic pictures or designs on the surface of stone or metals, so that impressions may be taken therefrom by the process of lithographic printing.

Dated 24th February, 1858.

359. S. Smith, Hyson Green Works, near Nottingham—Apparatus for insuring the correct action of the safety valves of steam boilers.
361. A. Hector, St. Cyrus, Kincardine, N.B.—Apparatus for taking fish.
363. C. Girardet, Vienna—New moveable shaft bearer, or supporter of coaches.
365. J. Petrie, Rochdale—Apparatus for regulating the flow of steam.
367. W. E. Newton, 66, Chancery-lane—The application to carts or other vehicles of apparatus for weighing the load contained in such vehicles.
369. H. Browing, Avon-cottage, Clifton-road, Bristol—Composition for covering iron and other ships' bottoms.
371. R. F. Miller, Hammersmith—Omnibuses.

INVENTIONS WITH COMPLETE SPECIFICATION FILED.

248. W. S. Clark, Atlas Works, Dorset-square—Copying presses.—February, 10th 1858.
299. C. Monson, Connecticut, U.S.—Apparatus to be used for supporting one or more gas burners, and conducting gas to such, or for various other useful purposes.—17th February, 1858.
370. W. K. Foster, State of Maine, U.S.—Manufacture of blades for pencil sharpeners.—24th February, 1858.
386. A. J. Dessales, 13, Rue des Enfants Rouges, Paris—Oil lamps for railway carriages, &c.—27th Feb. 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4060. Feb. 22. C. Weintraud, jun., Offenback, in the Maine, Germany, and 4, King-street, Cheapside, "Improved Purse."
4061. „ 24. Bell and Black, Bow-lane, City, "A Box for Containing Wax or other Matches."
4062. „ 26. J. Lang, 22, Cockspur-street, Charing-cross, "Self-acting Lever for removing Cartridges when fired from Breech-loading Guns and Rifles."
4063. March 1. T. Pettiver, Trinity-street, Islington, "Improved Swing Kettle Stand."
4064. „ 4. R. Ramage, 55A, Holywell-street, Westminster, "Self-acting Valve Ventilator."
4065. „ 9. W. Reichenbach, 33 and 34, Borough-road, Southwark, "Improved Gas or Air-pressure Guage."
4066. „ 10. R. F. Sturges, Birmingham, "Metal for Forks, Spoons, and Ladles."

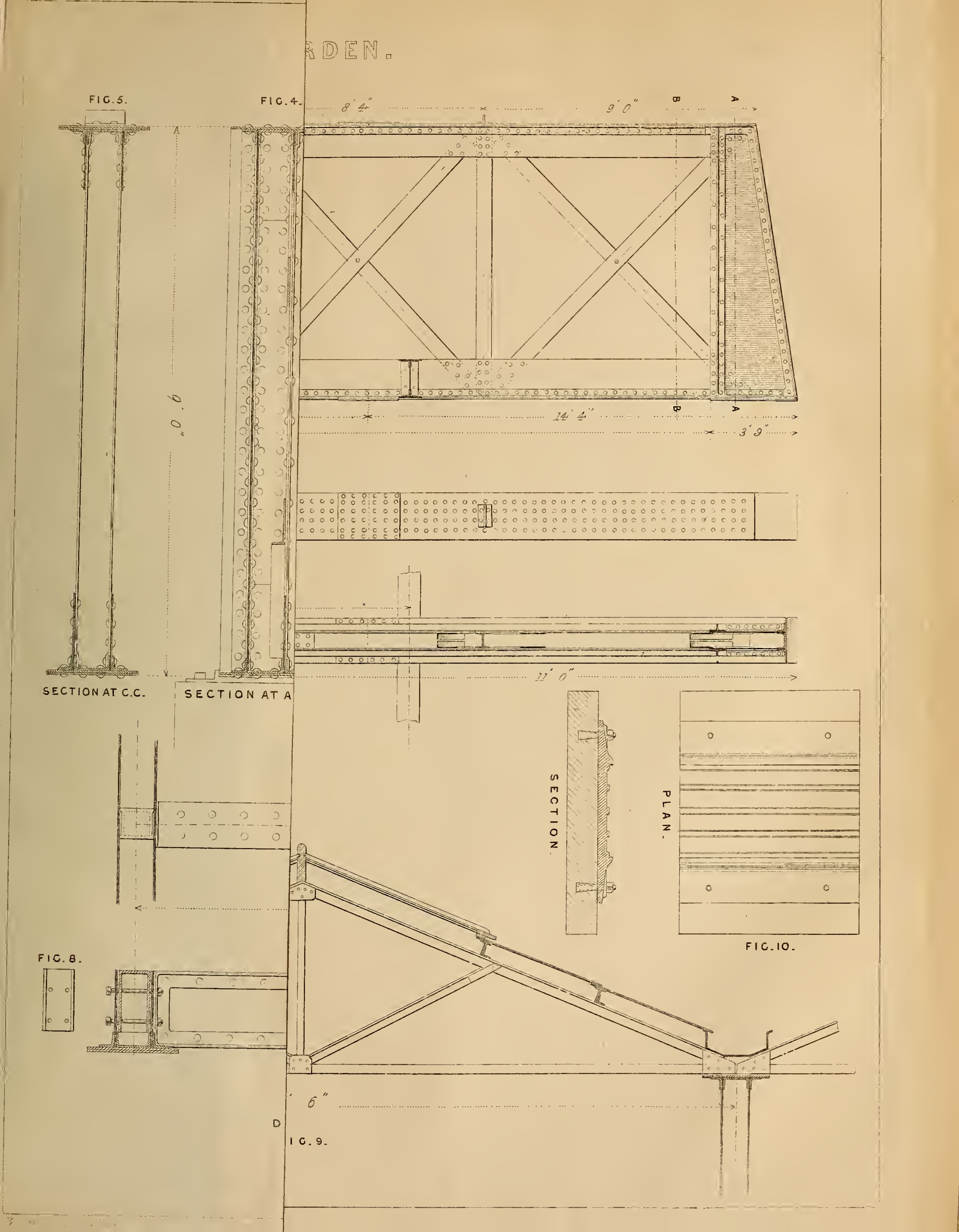

RDEN.
FIG.5.
FIG.4.
8'4"
9'0"
B
A
14'4"
3'9"
11'0"
SECTION AT C.C.
SECTION AT A
SECTION.
PLAN.
FIG.10.
FIG.8.
6"
D
IG.9.

FIG. 5

SECTION AT C.C.

FIG. 4

SECTION AT A.A & B.B.

FIG. 1.

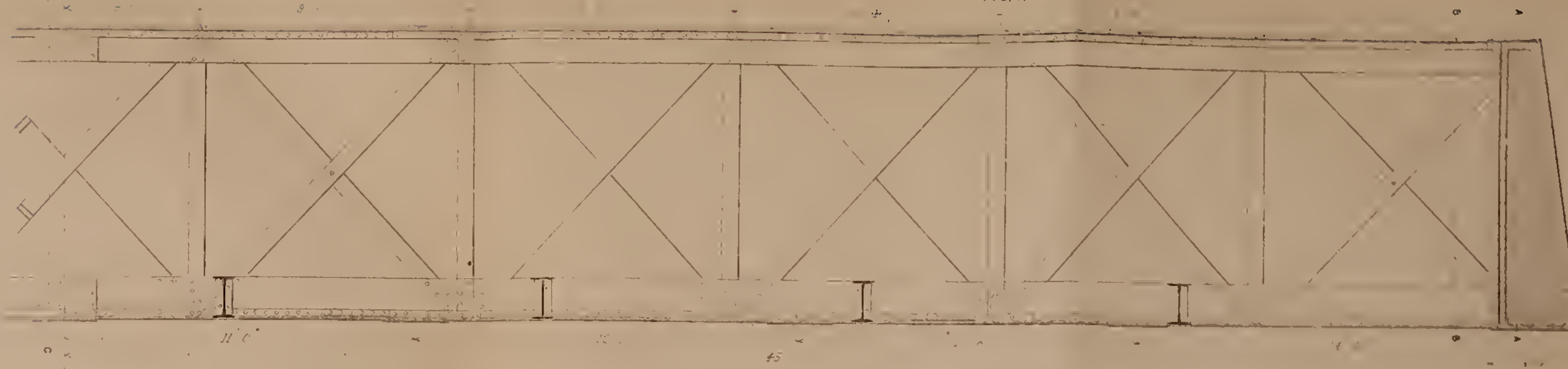


FIG. 2.

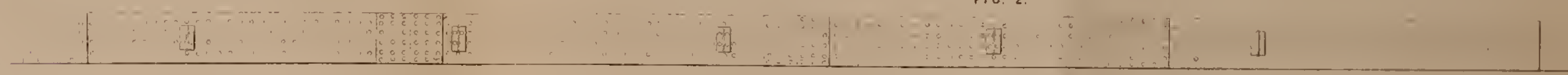


FIG. 3.

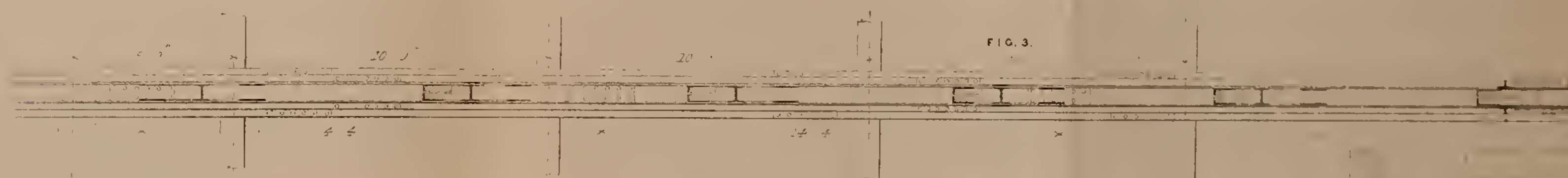


FIG. 6.

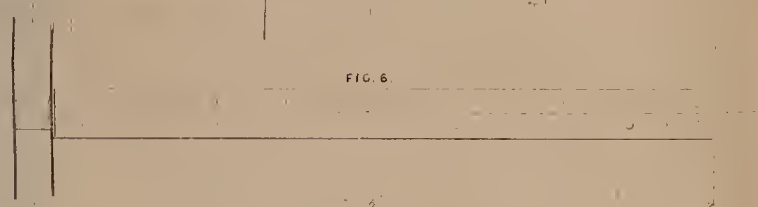
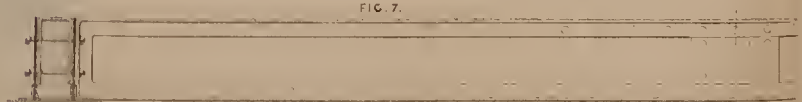


FIG. 8.

FIG. 7.



DETAIL OF TRANSVERSE GIRDERS.

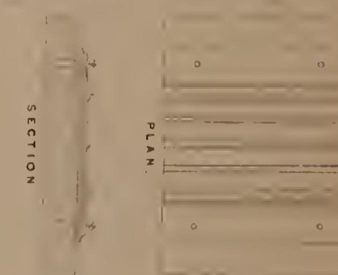


FIG. 10

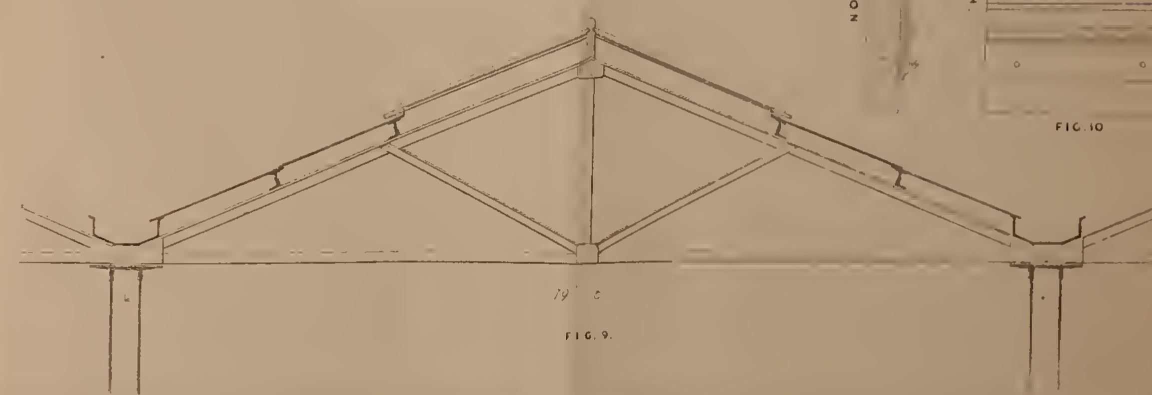


FIG. 9.

Fig. 1

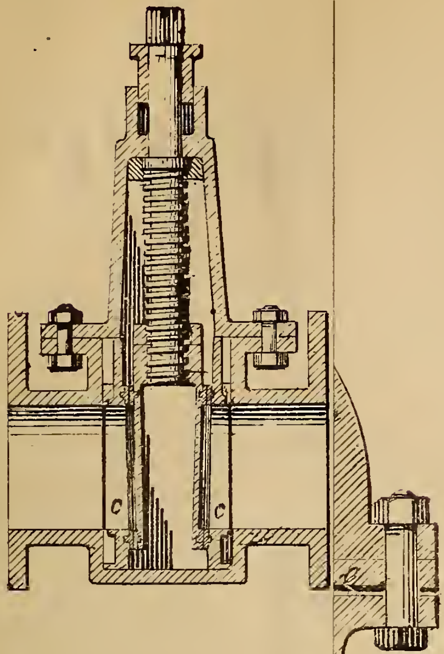


Fig. 7.

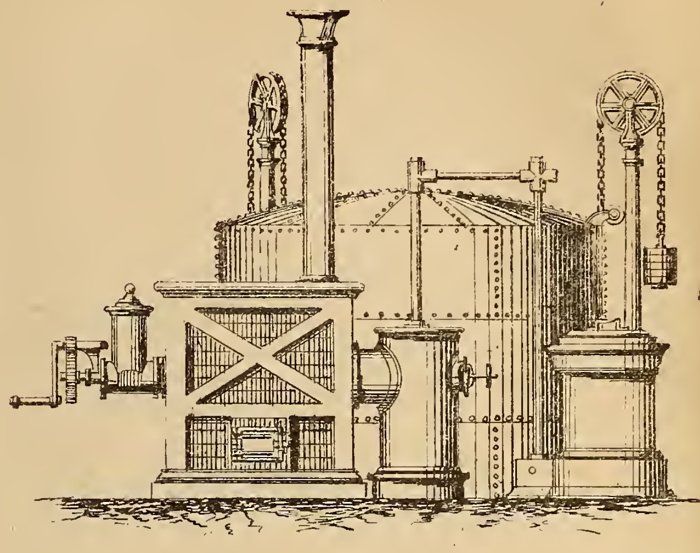


Fig. 2.

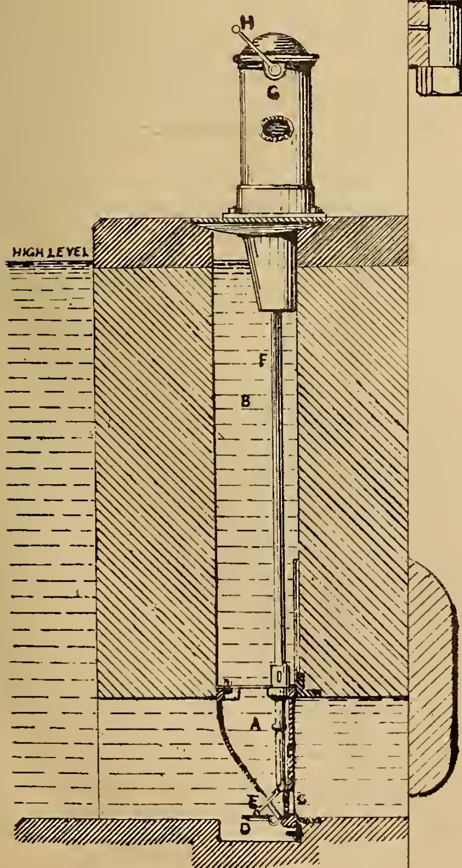
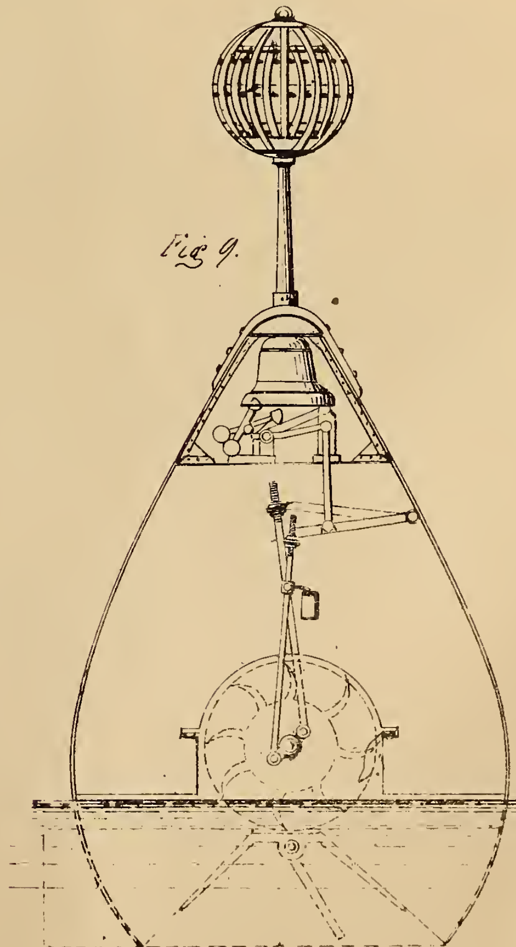
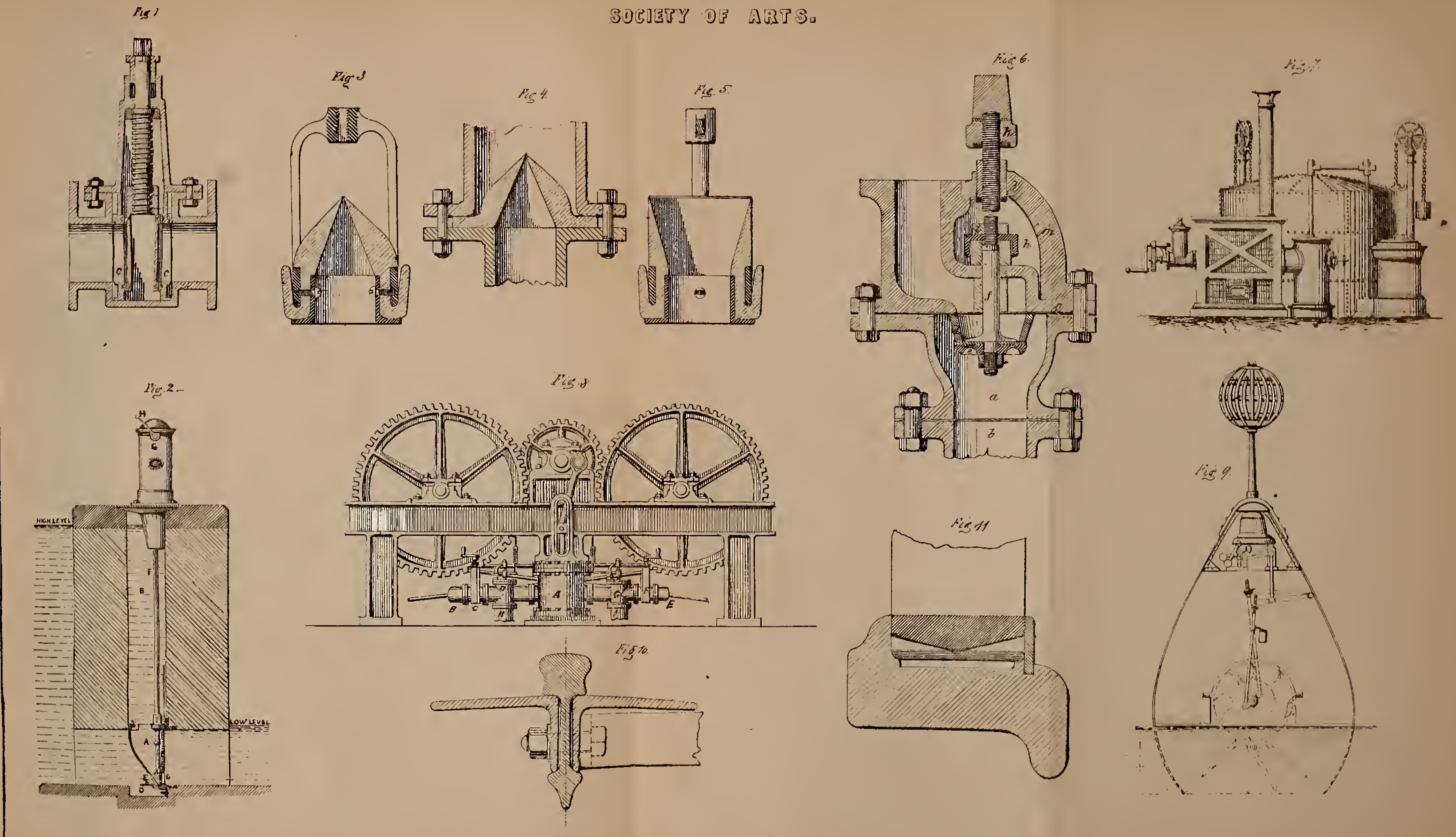


Fig. 9.



W. Smith C.E. Direx

EXAMPLE OF INVENTIONS EXHIBITED AT THE SOCIETY OF ARTS.



W. Smith C.E. Direx

THE ARTIZAN.

No. CLXXXIV.—Vol. XVI.—MAY 1st, 1858.

THE IRON ROOF AND TRELLIS GIRDERS OF THE ROYAL ITALIAN OPERA, COVENT GARDEN.

Plate cxxii.

It is supposed that but little that is novel, or of scientific interest to the engineer, remains to be said upon the subject of the construction of iron roofs. Within comparatively few years, iron has been extensively employed as the material of which the framework of roofs for covering almost every description of building has been constructed. Railway stations have, however, afforded the greatest field for exhibiting the constructive talent of iron-roof designers; and the importance of spanning openings of great width, without the intervention of supporting columns, has stimulated the engineer and the architect to the employment of their inventive talent and constructive ability; and the greater facilities which now exist for obtaining iron in every conceivable form, has materially assisted the development of the application of that material to so important a purpose, and for which, too, it is so admirably fitted, combining, when skilfully and judiciously applied, great strength with lightness and elegance of appearance.

The most recent noteworthy example of iron-roof construction is the one which we have illustrated in the accompanying Plate, No. cxxii., possessing, as it does, features of special interest. The ridge and furrow system of roofing has, since Messrs. Fox and Henderson so successfully demonstrated its advantages, become a great favourite with engineers for covering considerable areas, without the necessity for the constructions of great height, common to any of the ordinary and well-known forms of roofs employed for covering openings of any magnitude; and Mr. Edward M. Barry, the architect of the new Royal Italian Opera, has, in our opinion, most judiciously adopted the ridge and furrow roof for covering that building.

In the roof proper there is nothing which calls for very special remark; whilst in the trellis girders which support the roof, not only novelty, but considerable ingenuity and constructive ability, have been displayed.

We do not propose, upon the present occasion, to depart from the very wholesome rule which we have heretofore followed, of adhering to subjects only directly within our province, and leaving architectural matters, and exclusively building construction, to the talented weekly contemporary journals, the "Builder" and "Building News;" but the subject of beams and girders for all kinds of engineering and building construction has been so fully treated of in The Artizan, that we should be wanting in our duty to our subscribers and the engineering profession, if we did not take the earliest opportunity of affording them the means of judging of the merits—as a piece of construction in iron—of the roof of the new Italian Opera House; and, moreover, we are induced to take the earliest opportunity of illustrating the subject, and stating our opinion as to the construction, and sufficiency of strength, and general suitability of the arrangement adopted by Mr. Barry;—perhaps, also, our love of opera and anxiety for personal safety may have exercised some influence in determining us to investigate the principles of construction, and to calculate the strength of the materials as applied therein;—knowing, also, the very natural timidity which persons unacquainted practically with the principles of such like constructions have as to their safety, when entering for the first time a building of such vast dimensions, erected in so short a time, and with several novel features in and about it;—and, moreover, as rumour, with her thousand tongues, has not failed to accept the opportunity of detailing all manner of doubts as to the sufficiency and stable character of the building—of the bulging of walls—the heavy settlements—the great fissures, and other fancied defects which are supposed to have occurred during the construction—and of the apprehensions which the "knowing ones" are said to entertain as to the safety of the building, and more particularly as to the security of the roof.

Now nothing can be more unfair to the architect and the contractors; and nothing so untrue, as we can testify,—and unreasonable, as we hope immediately to be able to show,—at least, with reference to the sufficiency of the roof; and thus much we think it proper to state at once, for the reputation of the architect, and the credit of the contractors, that we never saw more admirable and satisfactory work,—whether as to the brickwork and general construction, as executed by Messrs. Lucas, Brothers, or as to the ironwork, executed by Messrs. H. and M. D. Grissell,—and it is only a matter of surprise that such high degree of excellence should have been attained, considering the very great rapidity with which the building has been entirely re-constructed; but it is due to the professional talent of Mr. Barry, and the admirable arrangements made by him for providing for every contingency likely to arise in carrying forward such an extensive construction, that the work has been so successfully performed, and that the anticipations and evil forebodings which have, as usual, been plentifully circulated, are not fated to be realised; for, with upright walls of ample thickness, constructed with excellent materials now thoroughly consolidated, and with a roof of ample strength supported upon girders of more than ample ability to sustain their load, and which, from their principle of construction, put no lateral thrust upon the supporting walls, and therefore do not tend to force them outward, we have a structure more thoroughly suited to the purpose for which it is designed, possessing greater strength, and therefore safer, than any previous erection on the same site, and hence offering greater security for public safety at all times and under all circumstances.

At the commencement of the work it was resolved, that as far as practicable the building should be what is termed fire-proof. For this purpose, Mr. E. M. Barry had to consider the question of adopting an appropriate iron roof to sustain the great weight of so extended an area—having to carry first the slate covering, then a flooring, over the whole of the tie-rods, and the spaces between the girders being intended to serve as the carpenters' shops and store-rooms—as also to carry in addition the ceiling which had to be suspended from it.

Many objections necessarily arose as to using a trussed iron principal for such purpose, especially as the load upon the floor of a carpenter's-shop or store-room is necessarily varying, and frequently very unequal in its disposition. It was finally determined to abandon the old system of trussed principals, and Messrs. Grissell undertook to design a series of girders, which, placed at a distance of about 20 ft. apart, should be equal to the duty required, the result being the girder as engraved in our present Number.

Of course, for such a span, and to carry such a weight, no material was admissible but wrought iron; and dealing with this material, it became a question of the best section the girder should assume to carry a load of 150 tons over a space of 90 ft. opening. Lightness was a very important point when the height of the walls was considered, namely, nearly 100 ft. without any lateral internal support.

Not only is vertical strength required in this instance, but lateral stiffness also; and in considering the subject it became apparent that the trellis or lattice girder offered the greatest vertical strength consistent with lightness, whilst the box girder form offered the most lateral stiffness.

It became therefore desirable to see how far the principles and properties of these two descriptions of girders could be combined together, so as to produce a section which would unite the peculiarities of the two forms. It was, after some time, decided that the girder should be of the form of a three-sided box or trough for the top and bottom sections, and that the middle portion should be composed of two lattice girders, the depth of the girders when completed being 9 ft. This combination we believe to be new, and if the system should be found successful, the credit of the design of the girder, we are informed by Mr. E. M. Barry, belongs to Messrs. Grissell, who were assisted by their principal draftsman, Mr. Barrass.

As regards the roof, there is nothing new; it being simply the usual form of a light wrought-iron 20 ft. trussed principal, carrying large thick slates, with a glass skylight at the apex. There is nothing novel, as we have before stated, in the system of a number of small roofs running transversely to the building to form a covering, but we believe it to be the cheapest and best form of covering large areas of great spans.

The following is the Estimated Load on the 90 ft. span Trellis Girders over the Audience Portion of the Theatre:—

	Tons.	c.	qrs.	lbs.
10 principals of trussed T iron	1	10	0	0
11 bays of T iron purlins	2	3	0	0
90 lineal ft. of cast-iron gutters	1	8	0	0
1,980 ft. super. of slates, at 8 lbs. per ft.	7	1	1	0
,, ,, snow, at 10 lbs. ,,	8	16	3	0
,, ,, acted upon by wind, at 40 lbs. per foot, on a vertical plane ∴ 40·1980 sin. △ 21° 48′ (angle of roof)	11	18	2	0
8 transverse girders for floors	4	10	2	0
1,800 ft. super. of 1½″ flooring boards; 1,350 lineal ft. of 6″ × 3″ joists	8	0	0	0
1,800 ft. super. of loading, at 100 lbs. per foot	80	7	0	0
Contingency for ceiling	7	5	0	0
Trellis girder itself	17	0	0	0
Total distributed load on each girder = say	150	0	0	0

It is to be understood that these are not precisely the weights of the several parts as actually manufactured; but they differ so immaterially from the estimated weights, that the whole of the estimated loads are retained in their original integrity.

It having been determined to prove the girders with the above-named weight, two girders were completed and proved at the Regent's Canal Iron Works in the following manner:—

First of all, foundations of concrete were laid, and upon these were placed cross pieces of whole timbers, upon which the two girders to be tested were built, about 9 ft. apart. Before proceeding to place the weights, the ends of the girders were well stayed to keep them upright, while in the intermediate space between the bearings, cross braces of iron were fixed to the top and bottom of the girders, to preserve their parallelism, and act for the time being as the tie-rods of the roof and the transverse girders of the floors. As a means of supporting the pig iron with which the girders were to be tested, temporary floors were formed at both the top and bottom of the girders of bars of iron and boiler plate.

According to the estimated loads, we find that the maximum load on the roof, or rather on the top of the girders due to the roof, is about 40 tons, while the remaining 110 tons will rest on the bottom flange; and, therefore, to prove the girders under as similar conditions as possible to those to which they would actually be subjected, 40 tons were placed on the top, and the remaining 110 tons on the bottom of the girder.

The mode of testing and distributing the weights were as follow:—

Table of the Weights, their Distribution, and the Deflections at various Loads.

Weight on Top.	Weight on Bottom.	Total weights added.	Deflection of No. 1 in feet.	Deflection of No. 2 in ft.	Deflections in inches. No. 1.	Deflections in inches. No. 2.
		Tons. c.				
Two girders themselves		34 0				
Cross stays to do.		0 10	·000	·000		
Tons. c.	Tons. c. qr.					
Ty. Floor... 12 6; Pig Iron ... 7 14	Ty. Floor. 13 9 2; Pig Iron.. 16 10 2	50 0	·005	·005	$\frac{1}{16}$	$\frac{1}{16}$
Pig Iron ... 20 0	Pig Iron.. 30 0 0	50 0	·045	·060	$\frac{17}{32}$	$\frac{11}{16}$
Do. ... 20 0	Do. .. 30 0 0	50 0	·083	·083	1	1
Do. ... 20 0	Do. .. 30 0 0	50 0	·115	·115	$1\frac{3}{8}$	$1\frac{3}{8}$
	Do. .. 65 10 0	65 10	·160	·160	$1\frac{7}{8}$	$1\frac{7}{8}$
		300 0				
All weights removed. Permanent set			·03	·02	$\frac{3}{8}$	$\frac{1}{4}$

No. 1 girder was cambered 3 in. No. 2 girder was cambered 2½ in.

It will be perceived that girder No. 2, having a camber of 2½ in., was the strongest, as might have been anticipated; or, in stricter terms, that the several parts of No. 2 found their bearings, or had their due strains imparted to them, before that of No. 3, and, therefore, offering greater resistance to permanent deflection. The remaining girders were, therefore, constructed with a camber in the centre of 2½ in.

It may be useful to state that the area of bottom box, deducting rivet holes, is 30·6236 square inches for effective tension.

The area of top box, including rivets, is 33·764 square inches, to resist compression.

Tension in bottom box, 187·5 tons $\therefore \frac{187{\cdot}5}{30{\cdot}6236} = 6{\cdot}12$ tons' tension per square inch of section.

Compression on top box, 187·5 tons $\therefore \frac{187{\cdot}5}{33{\cdot}764} = 5{\cdot}05$ tons per square inch of section.

The great strength combined with the lightness of these girders is due to their peculiar form, and the distribution of the several parts,—the open box form of the top and bottom members giving the lateral stiffness of a box girder, the light diagonals through which the strains are transmitted to the walls obtaining the lightness of the trellis girder, while by the system of carrying through the length of the girder a double set of flat bars, acting in tension, and a double set of angle bars, acting in compression, so having four members transmitting the accumulating strains in the panels from the centre to the walls, and also attaching these several pieces on the system of close rivetting, all the security of a solid web plate girder is obtained at a very much reduced cost of material and labor in rivetting, thus obtaining a maximum of strength with a minimum of material.

On reference to the accompanying plate, No. cxxii., a portion of the length of one of the trellis girders is shown in elevation Fig. 1; Fig. 2 being a plan, and Fig. 3 a longitudinal section, taken on the plan, of Fig. 1. Figs. 1, 2, 3 being engraved to the same scale, namely, ¼ in. = 1 ft. Fig. 4 being two views, or transverse vertical sections, taken respectively on lines A A, B B. Fig. 5 being a similar section, but taken on the line C C, where the flat iron diagonals are introduced, instead

of the angle iron and flat bar diagonals, which compose the extreme divisions of the trellis. Figs. 3 and 4 being engraved double the size of Figs. 1 and 2, or $\frac{1}{2}$ in. = 1 ft.

In Fig. 1, sections of transverse girders are shown connected with the bottom member of the trellis girder, by means of which they are framed together, and these transverse girders act as bearers for supporting the floor of the carpenters' shops, &c.; they are of the form and dimensions seen at half-length, Figs. 6 and 7, to a scale $\frac{1}{2}$ in. to the foot, and project on each side of Fig. 3 in the positions corresponding with the sections shown in Fig. 1. Fig. 8 is one of forty-four blocking pieces intended to fill in between the bottom web plates of trellis girders at the points of junction of the transverse girders, as shown in Figs. 6 and 7, being bolted through with $\frac{3}{4}$ in. bolts and nuts.

The bearing pieces forming the ends of the trellis girders, and in which the top and bottom members and the diagonal braces terminate, are composed of a bottom bearing-plate of $\frac{5}{8}$ in. thick, 3 ft. long, and 18 in. wide; a back plate of the same width, 9 ft. 2 in. high, and $\frac{5}{8}$ in. thick, to which are rivetted two external angle-irons ; and the middle piece, or ⊓ iron, between the flanges of which the two side or cheek-plates, $\frac{5}{16}$ in. thick, are rivetted; the vertical pieces rivetted to the front of these cheek-plates, the top and bottom members, and also to the first set of diagonals, are 6 in. × 3 in. T iron.

The first pair of diagonal tension bars, extending from the top corner of the bearing-piece, or abutment, down to the lower member and foot of the first vertical strut, are composed of flat bars, 7 in. by $\frac{1}{2}$ in.; in the next division they are reduced to 7 in. by $\frac{7}{16}$ in.; in the next to 7 in. by $\frac{3}{8}$ in.; in the next, 7 in. by $\frac{5}{16}$ in.; and in the three centre divisions to 7 in. by $\frac{1}{4}$ in.

The pair of thrust-diagonals, extending from the foot of the bearing-piece, or abutment, up to the head of the first vertical strut, are composed of 6 in. by 3 in. L iron. The same scantling is preserved throughout ten of the sets of diagonals; that is, all, excepting in the centre division, which is entirely composed of flat bars.

The ten vertical struts are formed of two ⊓ iron bars, placed back to back, forming I shaped bars, against which the ends of the diagonals are rivetted at top and bottom. These are arranged to form nine spaces, each 8 ft. 4 in. centres, and the two end spaces are increased by the additional length of the abutments, as shown in Fig. 1.

The longitudinal bottom piece, or member, is formed of several lengths of plate iron, 18 in. wide, varying in thickness in each half length as follows:—14 ft. 4 in. of $\frac{1}{2}$ in.; 10 ft. 8 in. of 5-8ths in., 12 ft. of 3-8ths in., and 11 ft. of $\frac{7}{16}$ in. The two vertical side plates or webs are 15 in. deep × $\frac{5}{16}$ in.; these are rivetted between two external L irons, each 3 in. × 3 in. × 3-8ths in., with a spacing piece of ⊔ iron, 7 in. wide × 3 in. deep; these are rivetted together with $\frac{3}{4}$ in. rivets, 4 in. apart; and the cover-plates or strips for the bottom or horizontal plates are 18 in. wide, 24 and 26 in. long, and $\frac{1}{2}$ in. thick, rivetted with 36 rivets; the joints of the longitudinal angle iron and ⊓ iron bars are made with lapping pieces, 2 feet long, and rivetted with $\frac{3}{4}$ in. rivets, 4 in. apart; the vertical web plates are likewise jointed by plates 3 ft. long, 12 in. deep, $\frac{1}{4}$ in. thick.

The longitudinal top piece or member is constructed like the bottom piece, the top plate being 18 in. wide and $\frac{1}{2}$ in. thick throughout; the external longitudinal L pieces 3 in. × 3 in. by 3-8th in.; the ⊓ iron spacing pieces are the same as in the bottom; the two side plates are 12 in. deep each by $\frac{5}{16}$ in. thick; the diagonals are rivetted to the side plates and verticals near the extreme ends by $\frac{3}{4}$ in. rivets. Towards the centre of the girder, 5-8th rivets are used; the angle and ⊓ irons are rivetted with $\frac{3}{4}$ in. rivets, and the cover plates for the joints for both the horizontal and the vertical longitudinal plates of the upper member are 24 in. long, and generally $\frac{1}{2}$ in. thick.

Over each vertical a short T iron thrust-piece or shoe is rivetted, as shown in elevation, Fig. 1, for receiving the principals. These will be seen in position on reference to Fig. 9, by which the roofs covering the spans, varying from 19 ft. 6 in. to 21 ft. are shown as resting upon the top of each pair of girders; the T iron pieces are 5 in. × 3 in. × 8 in. long, punched with two holes for $\frac{3}{4}$ in. bolts, each pair of principals being secured by $\frac{3}{4}$ in. bolts. Immediately above each trellis girder, and of the same length, are fixed the iron trough gutters, 16 in. wide, forming the furrows, as will be seen on reference to Fig. 9, which figure also shows the general arrangement of the roof over a 19 ft. 6 span, from centre to centre of trellis girders. It is formed of trussed T iron, the slate slabs being about 3 ft. to 3 ft. 6 in. each, supported upon T iron purlins, light being admitted by sky-lights, about 4 ft. 3 in. wide, on each side of the ridge.

We must defer, until some other opportunity, giving a description of the method adopted by Messrs. Grissell for erecting the trellis girders in their places.

Having described these works at greater length than was originally our intention, and far exceeded the space which we can afford to devote in one Number, it remains only for us to state, that the amplitude of strength of the whole of the ironwork in the roof is beyond a doubt, and that the practical results of the experiments made with the two girders, whilst under proof, so thoroughly agree with the results of theoretical calculations made before determining upon the adoption of the plan, are very satisfactory, and reflect credit on all concerned, and it should be highly re-assuring to the patrons of the opera and the public.

The method of supporting the boxes possesses also a feature of novelty. There are four tiers of iron columns, one above the other; these support the pit corridor, and three tiers of boxes upon it. The diameters of the columns are respectively 9, 8, 7, and 6 in., their thicknesses varying much in the same proportion, being $1\frac{1}{2}$, $1\frac{1}{4}$, $1\frac{1}{8}$, and $\frac{7}{8}$ in. of metal; these are fixed by the cap and base plates tenoning into one another, and are secured by four bolts. The heads of the columns are cast in a box-like form, to allow the wrought-iron girders or cantilevers to pass through them; whilst at the sides, provision is made to receive the binders or cross-girders.

The feature of novelty which struck us as pertaining to this part of the work, was the mode employed in constructing the wrought-iron cantilevers, it being a demonstration of the neutral-axis principle in girders ; for here are two T iron bars, the heads of the T's forming the top and bottom flanges, whilst the middle web is formed by the vertical limb of each of the T's being brought edge to edge and butted ; thus the longitudinal line of junction forms the neutral axis. It is upon overhanging girders or cantilevers of this construction that the boxes are supported.

We observe, too, amongst the many well-considered arrangements provided by Mr. Barry against the various contingencies of possible occurrence, one, providing for the effect of settlement in the external walls, in relation to the columns, which are supported upon the low wall forming their base line; this is, by the introduction of packing-pieces and keys in the heads of the columns, so that, should the settlement have been considerable, or unequal, this arrangement permitted of the girders supporting the corridors and boxes being accurately levelled.

In concluding we may add, that the re-erection of the Royal Italian Opera House reflects the highest credit upon all who have been concerned in that work ; and not the least creditable is it, that so far, the whole has been performed with scarcely the slightest accident.

THE TENTH EXHIBITION OF INVENTIONS AT THE SOCIETY OF ARTS, 1858.

Illustrated by Plate cxxiii.

The Tenth Annual Exhibition of Inventions was opened on Monday, 5th April. We are unable to discover the usual number of models of novel and practically useful inventions ; on the contrary, we find that a considerable proportion of the models exhibited are either old and well known, or of but mediocre merit. We have selected and illustrated,

in Plate cxxiii., such as we have, however, thought most deserved recording, although there are several others which possess merit, but could not be conveniently illustrated.

If the Exhibition possesses any features of novelty, they are chiefly to be found amongst the drawings suspended upon the walls; and we think that it is much to be regretted that this class of illustrations should be so much more extensively employed than formerly, as we are convinced, from past experience of exhibitions of inventions, that actual machines, or working models thereof, and specimens or samples of manufacture, accompanied by a short description, are very much to be preferred for practical educational purposes, and should, therefore, by preference, be encouraged by the Council of the Society of Arts, amongst whom there should be some members competent to judge of such a matter, and able to judiciously select and regulate the exhibition of such articles, and so prevent the Society's rooms being used partly as a toy shop and partly as an old mechanical curiosity shop, for, when visiting the present Exhibition, we have heard the better class of practical mechanics apply both terms to the Tenth Exhibition of the Society of Arts.

The few objects which we have selected for illustration we have thought it better to lithograph, and give in a separate sheet (Plate cxxiii.), instead of occupying the space devoted to letter-press (with two or three exceptions).

Messrs. Wheatcroft and Smith exhibit an improved Hydrant, see Fig. 6.

The valve chamber or cylinder, *a*, as forming one part of the hydrant, is intended to be connected, as shown, to the branch from the main pipe, *b*. On the cylinder, *a*, is placed a top plate or conducting pipe, *c*, to which it is attached, forming part thereof; the projecting chamber or valve seating, *d*, is of any required dimensions, but having a less area than the cylinder, *a*, so as to pass into the cylinder, and allow sufficient area for the escape of water that may be required. Upon the projecting chamber or valve-seating is placed the valve, *e*, with its spindle, *f*, passing through the top plate, and also through the india-rubber spring and packing, *g*, enclosed in the box, *h*, so that the spring may not be injured by the nut, *i*, in the top of the valve spindle. When the nut is screwed down, it gives an elastic force to the india-rubber spring, having the effect of keeping the valve close and firm to its seating, thereby preventing waste of water or other fluid. In order to open the valve, and permit the liquid to escape, the action of the india-rubber spring is overcome by applying force to the top of the valve spindle by means of the screw, *k*, having a large square head at the top to acquire purchase, the screw working in a nut, *l*, in the standard or frame, *m*, fixed to the top plate; or a lever and weight, or a lever only, may be employed to effect the same object. The valve may be mounted with leather, or left plain, and the flanges and passages constructed of any size and shape, adapting them to house taps, stand pipes, and other requirements; but whatever modification is adopted, the valve or disc is held tight by an india-rubber and packing spring, when no liquid is required to pass, and the force of the said spring overcome by a lever or screw, so as to open the valve, when the conveyance of liquid is to take place.

Messrs. Charles Botten and Son exhibit a design for a sluice-valve, which we have illustrated by Fig. 1.

In the construction of this valve, *loose* faced plates, c c, are introduced, with an elastic substance, *f f*, behind them. Against the gun-metal faces of these plates the slide closes. The slide is wedge-shaped, and the advantages gained by this arrangement are: firstly, the ensuring perfectly true contact between the slide and faces, even if not quite truly fitted; secondly, these faces may be taken out without removing the body of the valve or breaking the joints; thirdly, the top with screw, &c., can be removed, leaving the slide shut.

Messrs. Perreaux and Co. exhibit specimens of their excellent valves, which merit the attention of engineers. See Figs. 3, 4, and 5.

These valves are constructed entirely of India-rubber, vulcanized for the purpose, and take the form of a tube flattened at one extremity, something similar to the mouth-piece of a hautbois, and approaching as nearly as possible in form and action the valves contained in the human heart. The thickness of the sides of the upper part diminishes gradually to the top, where the two sides meet and form lips, which, when the valve is in a state of rest, are in close contact, and prevent the downward passage of the fluid. With any upward pressure, the lips freely separate and allow of the upward passage of the fluid. The gradual tapering of the sides forming the lips of the passage, enables the valve to open and close with the slightest variation of pressure, and, by properly proportioning, to resist any required amount of downward pressure. The passage for the fluid is larger in these valves than in any others of equal dimensions. They also possess the advantage of having a "clear way," there being nothing to retard the passage of water; and owing to the self-acting principle imparted by the elasticity of the material, they close perfectly and instantaneously the moment the pressure from below ceases.

Mr. Herbert Mackworth, C.E., exhibits a model of a machine for crushing and dressing metalliferous slags and stones, and another machine for crushing shale containing iron-stone. He also exhibits a coal purifier or washer, which is said to perform its work admirably; but we are not informed of its merits, as compared with the admirable mineral washing machine invented by Messrs. Edwards and Beecher, which has been illustrated in The Artizan.

Mr. W. B. Adams exhibits several of his inventions connected with railway construction, and we have selected one example of permanent way for illustration, see Fig. 10, being a girder rail, one of Mr. Adam's "Century of Inventions."

This specimen is similar to those used on the Bombay and Barroda Railway. The depth of rail is the same as the double-headed rail; the total width is 12 in. It was produced by the Rhymney Company. These systems of rails require no skilled labour to lay down, either on ballast or on natural ground. They require little maintenance, lying steady, and possessing the same mechanical elements of stability as a well-built ship—broad beam, deep keel, and no top hamper. As the bearing is on the surface of the ballast, the moisture in the earth or ballast is forced upwards, instead of lying in pools below; and, calculating by the quantity of ballast used in the cross sleeper-road, one-half the amount will serve for the girder-rail. In maintenance, the ordinary "beating" is not required; the rail is lifted, when necessary, by a long lever passed below it, in the form of a long wave, without bending at the joints, and the ballast is shovelled under it. The bolts do not get loose, being embedded in the solid ballast, and the rail is, at the same time, sufficiently elastic to prevent rigidity at high speeds by a slight vertical yielding of the angle-brackets.

There is another invention of Mr. Adams's that is worthy of note—viz., an improved railway wheel, which has been tested for several months on the Eastern Counties Railway, and elsewhere. It is illustrated by Fig. 11. Mr. Adams places an elastic substance between the tyer and the wheel, by which a lighter tyer and wheel may be used, and wheels upon this principle may be put together cold. It is proposed to use a hoop of spring steel about 3 in. wide and $\frac{3}{16}$ in. thick, resting upon two fillets, as shown in the section.

Messrs. T. Wright and Co. exhibit a number of sleepers, chairs, and other railway apparatus, the chief feature of which is the employment of iron in every part of permanent way construction.

Mr. Edward Finch exhibits a model of a railway break.

This invention consists in a means of altering the position of the lever in respect to the axis by which the breaks are actuated, so as to compensate for the wear of the blocks, and by this means always to maintain the lever in the same position in relation to the carriage or waggon. For this purpose, the end of the break lever is arranged so as to move on the axis by which the breaks are actuated, and the break lever has attached to it a worm which takes into a worm wheel on the axis, so that as the blocks are worn away, by turning the worm attached to the break lever its position can be adjusted, so as always to retain the same position in relation to the carriage or waggon.

Mr. R. K. Aitchison exhibits a very good omnibus and carriage break.

This break is self-acting. When the horses stop, the backward thrust of the pole acts upon two levers, which apply the breaks. The same effect is produced by the carriage overrunning the horses in descending a hill. When the horses begin to draw, a spring releases the breaks. There is a treadle by which the driver can lock the pole, and thus prevent the break from acting when backing, or when otherwise desirable.

Mr. J. T. B. Porter, of Lincoln, exhibits a design for a very complete and snug gas-making apparatus, see Fig. 7, the chief feature, beyond its compactness and completeness, being the mode of charging the retorts, and screwing the charge forward.

This apparatus is suitable for the manufacture of gas, either on a large or small scale; but it is peculiarly adapted for supplying private houses, workshops, railway stations, lighthouses, and ships, and consists of a retort placed inside a case lined with fire-brick, such retort being furnished with an Archimedean screw for the facility of supplying it with fresh material, the screw at the same time discharging the coke or other carbonised substances which have been exhausted of their gas. Each charge of the retort is led at one end through a vertical pipe, having a flange fixed on its upper end, into which a plug is fitted; this pipe opens into a chamber in which the screw works, and as fast as the material is exhausted of its gas, it is pushed out by the screw at the opposite end and replaced by fresh material, which is traversed through the retort by occasionally turning the screw; this may be done by a winch handle, fly-wheel, or gear work fitted for that purpose. The coke or other substances from which the gas has been exhausted fall through a descending discharge pipe into an iron vessel, or a reservoir of water, if required, and may be removed in any convenient manner. The gas passes up through a pipe to the condensing and purifying apparatus.

Messrs. Batho and Bauer exhibit a very useful construction of planing machine.

The novelty of this machine consists in the manner in which the object operated on may be adjusted, and the arrangement of the link motion, to effect a

quick return, as well as uniform motion, whilst cutting. To the underside of the table is attached a screw, the nut on which is connected with the link, so that in planing an object of a hollow square form, it is not necessary to travel over the centre opening.

Mr. Andrew Shanks exhibits a double-action traversing drilling machine, something like Messrs. Sharpe, Stewart and Co.'s machine, of which a Plate was given in The Artizan some time ago. Of Mr. Shanks's machine it is stated—

This machine is especially adapted for making cotter-holes, mortices, or key-ways in metal; also for grooving shafts, axles, &c. The article operated upon is placed in the centre of the machine by means of the concentric vice and poppet headstud, the two drills being driven by top driving, like an ordinary lathe, the diameter of the drill determining the width, and the variable crank at the end of the machine operating on the carriage determining the length of the mortice or groove required.

Mr. B. Beale exhibits an improved method of cutting and shaping spokes for wheels. The peculiarity of Mr. Beale's machine consists in so constructing the machine and mounting the spokes to be operated upon therein, and operating upon them by a cutting tool while revolving round or oscillating on a centre eccentric to the centre of the spoke; the tenons being cut and the shaping of the spoke completed, both at the nave and felloe ends, in a similar manner.

Mr. A. Smith exhibits the model of a horizontal rope-making machine, being the same in principle as the machine for making rope and telegraph cables patented by Messrs. William and A. Smith in March, 1852, and which was employed by Messrs. Glass and Elliott in making the strands for the Atlantic Telegraph Cable.

Lieut. E. Manico, R.M., exhibits an invention, under the title of "Caisson de Fer," for obtaining foundations for marine and other structures. He describes his invention as follows:—It is proposed to construct it about 3 ft. square, of 3-in. by ½-in. flat iron bars, put together with bolts and nuts, forming an iron crate, or open packing frame. He then fills the interior with rough stones, or any other suitable material, so as to obtain a weight per cube yard of upwards of 2 tons. He considers that they can be advantageously used in the construction of harbour works, in the reclamation of land from the sea; and Mr. G. P. Bidder might, we think, with some advantage employ the Caisson de Fer in his Netherlands land enclosure operation.

Mr. R. R. Grantham exhibits a model of a chambered graving dock.

Messrs. Lawrence, Brothers, exhibit a sluice for canal locks, which is shown at Fig. 2.

In this invention the pressure of the water against the sluice is made to assist in raising it. In the engraving, A is the paddle or sluice, the upper part fitting the chamber, B; C, small valve or sluice; D, small flap-valve connected with the valve, C, by the link, E, so that when C is raised, D is closed; F, rod to machinery, G; on turning the winch handle, H, the rod, F, is raised, opening the valve, C, and closing D, allowing the water from the chamber, B, to run off to the lower level through the opening, C. The high-level water then presses in an upward direction against the sluice, A (the water in the chamber having been run off as described), and forces it upwards, the rising being regulated by the machinery, G. In locks, the water is generally at the same level on either side when the sluice is required to be lowered, in which case it descends by its own weight; but, should it be required to lower the sluice against a pressure—that is, when the water is running from one level to the other—the rod, F, in descending, closes the valve, C, and opens D, allowing the water in the upper level to fill the chamber, B, producing an equilibrium of pressures, and the sluice is then lowered by the machinery.

Messrs. J. M. Hyde and Co. exhibit a model of the stern of a screw steam-ship, fitted with sliding-plates for enclosing the space in which the screw revolves, thus reducing the resistance offered when a ship is under canvas, and the screw not in use; the plates slide up and down in grooves.

Mr. James Hodgson, Messrs. Finch and Heath, and Mr. S. Dyer, exhibit plans for constructing iron masts and yards.

Messrs. W. and M. Baylis exhibit specimens of chain cable fitted with hollow studs, but we are under the impression that this plan which they claim as a patent has been in use in America, and was exhibited by an American engineer, some time ago.

Mr. G. W. Lennox exhibits a bell buoy, see Fig. 9, Plate cxxiii.

This invention consists in applying an undershot water-wheel in the centre of an iron or other buoy, through which a pipe or water-course is made, the lower or downward paddles of the wheel being driven round by the water passing through the trough. At each end of the spindle of the water-wheel is a crank, which works an apparatus arranged in such a manner as to constantly ring a bell, which is fitted on the top of the buoy, so long as the current runs through the water-course. The alarm will thus be given to all vessels approaching dangerous reefs or shoals in tide-ways, in dense fogs, calms, or dark weather, for upwards of twenty-two hours out of the twenty-four. The same description of wheel can be fixed in a frame, and, being thrown over the stern or side of a light vessel, can be made to act in a similar manner.

Mr. Ralph Reeder exhibits his mariners' time compass, which has already been noticed in The Artizan several months ago.

Captain Blakely, R.A., exhibits his patent mortar. The peculiarity of this mortar consists in the whole being made in concentric layers, each slightly compressing that within it, so that when the strain comes, all may be strained nearly equally. In a cast mortar the interior must be strained much more than the exterior. It is stated that this arrangement gives greater strength at a cheaper rate, and affords facilities for making ordnance of a size hitherto found to be impossible.

Messrs. Pastorelli and Co. exhibit their improved surveying level. The peculiarities of this instrument are—an improved tripod or staff-head; the substitution of a ball-joint and clamp for the ordinary parallel plate-screw; an improved mode of suspending the telescope; the adjustments are rendered less liable to derangement; and there are improvements in the arrangement of the diaphragms. They also exhibit Metford's improved levelling staff and pocket scales; likewise Froude's proportional compasses. The peculiarity of this instrument is this: that it can at once be set, not only to any known ratio, but to any ratio which is not known, but which is only indicated by the length of two given lines; the instrument being set, the value of the ratio can be immediately ascertained by referring to a graduated scale.

Amongst the building, sanatory, and domestic appliances exhibited, are many things which will be found illustrated in the advertising columns of "The Builder" and "Building News," during the last twelve to twenty-four months, and several of the cuts seem to be borrowed from that source.

Amongst the drawings are some excellent railway turn-tables, and two or three engineering matters more or less novel.

Mr. B. Beale exhibits the drawing of an improved apparatus for paying out and drawing in electric telegraph cables. See Fig. 8, Plate cxxiii.

The improvements consist of an arrangement of machinery that will act as the retarding apparatus, when paying out the cable, by forcing or drawing, or by forcing and drawing air, gas, water, or any other fluid, which apparatus will act as the motive-power engine for hauling in the cable, when the pressure of steam, air, gas, water, or any other fluid, is applied for such purpose. The engraving represents a front elevation of a machine constructed with two pairs of grooved pulleys, having the cable wound round them. A is a cylinder, fitted with a metallic piston and a slide valve, the latter wrought by an eccentric, similar to a full-pressure non-condensing steam-engine. Three of these engines are preferred in connexion with the same crank shaft, with the cranks set at equal angles with each other, to ensure steadiness of action. B is an inlet pipe, in connection with a small air-vessel at H, and, in common with the three cylinders, fitted with a stop-valve, C, and vacuum-valve, D, having a lever and a Salter's spring-balance attached. E is an outlet pipe, in connection with a small air-vessel at I, and in common with the three cylinders, having a stop-valve, F, and escape-valve, G, also fitted with a lever and a Salter's spring-balance; this outlet pipe is connected with a suitable boiler, which is to supply steam when the apparatus has to be used for hauling in the cable. The motion of the machine is given by the running out of the cable, which turns the wheels with the shafts and cranks, which, through the intervention of the connecting and piston rods, give a reciprocating motion to the pistons, drawing air (the stop-valves being closed) into the vacuum-valve, D, and forcing it out through the escape-valve, G. If the vacuum and escape valves be open, the strain on the cable will be but little more than that due to the friction of the machine.

MOY BRIDGE.

This bridge, now on the eve of completion, has been built under the joint direction of Messrs. Davison and Williamson, county surveyors for Armagh and Tyrone.

It was commenced early in May, 1856, by the contractor, Mr. Dargan, and is an elegant structure of three arches, crossing the river Blackwater at Moy, and connecting the counties of Armagh and Tyrone.

The foundations were formed on piles and concrete; the piles being alternately beech and Memel balk, driven from 24 to 30 ft. in a tenacious marly clay and sand bottom.

On these were laid Memel balk, screwed down to the piles, the concrete being brought level with their upper surface, and on this the stonework was laid. The piers, abutments, retaining halls, and parapets are built of limestone from the quarries of Benburb and Robertstown; and the arch, sheeting, and ring stones are of sandstone, chisel dressed.

The cost is about £7,500; and the carrying out of the design reflects considerable credit on Mr. Edwards, the gentleman employed by Mr. Dargan to superintend the works on his part, and indeed all those connected with the erection.

The river Blackwater being chiefly supplied by mountain streams, is subject to sudden floods, especially after snow and heavy rains, and great fears were entertained for the durability of the coffer dams, but they stood out their work bravely; and in connection with Mr. Dargan's name this bridge adds another to the many honours so well earned in his native country.

MUNTZ'S IMPROVED PADDLE-WHEEL.

Mr. W. H. Muntz, of Birmingham, has invented what he states to be, as the results of experiments, an improvement over the ordinary wheels in use; and the accompanying illustration will exhibit the features of Mr. Muntz's paddle-wheel.

The following are the literal references relating to the several parts of the wheel, shown in figures 1 and 2. The inventor states:—

I construct the rims or supports of the floats of one large middle or cutwater rim, A, and two side rims of smaller diameter, B B. By this construction I am enabled to place the floats at an angle from their base, C, where they join the smaller rims, and their points, D, where they join the middle or cutwater rim, A, thus getting rid of the vibration or concussion, by causing the floats to enter the water almost edgeways at the points (as seen in side elevation of the wheel, the arrow denoting the vessel's course). I prefer the float approximating the shape of a bird's wing, though the shape may be varied. Obtaining a deeper dip by sub-

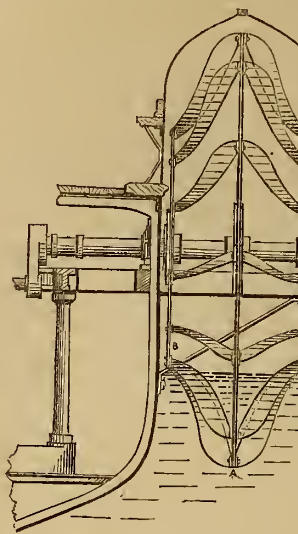


Fig. 1.

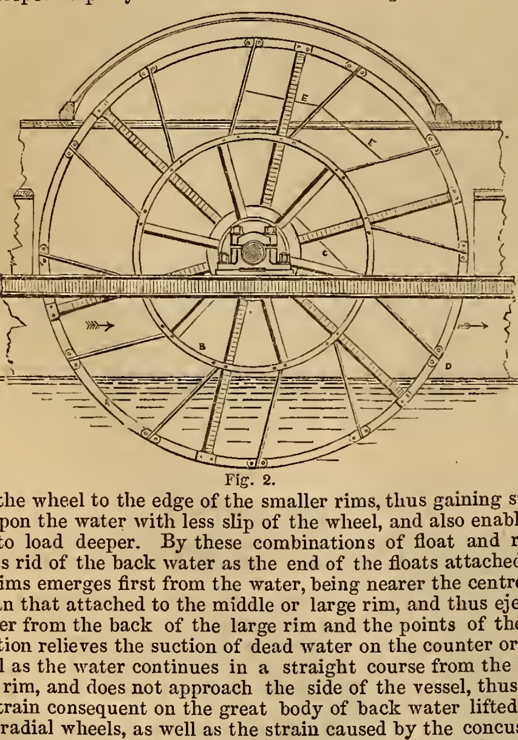


Fig. 2.

merging the wheel to the edge of the smaller rims, thus gaining strength of hold upon the water with less slip of the wheel, and also enabling the steamer to load deeper. By these combinations of float and rim, the wheel gets rid of the back water as the end of the floats attached to the smaller rims emerges first from the water, being nearer the centre of the wheel than that attached to the middle or large rim, and thus ejects the back water from the back of the large rim and the points of the floats, which action relieves the suction of dead water on the counter or run of the vessel as the water continues in a straight course from the back of the large rim, and does not approach the side of the vessel, thus avoiding the strain consequent on the great body of back water lifted by the ordinary radial wheels, as well as the strain caused by the concussion of the wheel entering the water. With these wheels the vessel is propelled at greater speed than by the ordinary wheels, as the power is almost entirely applied in the same line as the keel of the vessel. By the deep dip the engines are prevented running away with the wheels when in heavy weather, as the wheels scarcely roll clear of the water. To get rid of the strain on the shaft, I would observe that these wheels can be constructed much narrower than the old ones on the face, the area of the floats being applied in the depth of the dip, instead of the width of the face (as is the case in the old wheels); thus the shaft need not be so long, and consequently not so liable to break. Next, reducing the action of the wind in retarding the speed of the vessel by building the paddle-boxes the same shape as the wheel, thus making them sharp to a point, both fore and aft, as well as on top, exactly as an inverted life-boat, which enables them to cleave the air much easier than the old paddle-boxes. The number of floats in the wheel can be varied, though I prefer the few floats, as I am of opinion that the less the body of water under the wheels is disturbed, the more power is obtained.

By building the wheels on this plan they are stronger, as each pair of floats act as a shore brace to the rims of the wheel, and the large rim, A, acts as a guard in throwing off obstacles in the way of the wheel. E represents a series of iron stays when required, with shoulders above and below each float, the stay extending from float to float, to strengthen them when striking ice, &c., as may be seen by referring to the annexed diagram. The dotted lines show the eccentric motion of this wheel with the floats in different positions, as seen in this side elevation of the wheel.

ON THE PADDLE-WHEEL AND SCREW-PROPELLER, FROM THE EARLIEST TIMES.**

By John MacGregor.

The approaching trial, for the first time, and on the grandest scale, of the paddle-wheel and screw-propeller in the same vessel, may well suggest the consideration of these two instruments in the same paper, while they are so different in origin and operation that it will be best to treat of each of them separately.*

We shall begin with the paddle-wheel, as the older method, though the other was first matured, and is now the more popular.

Several modern writers state that the paddle-wheel was used by the ancient Egyptians, but I can find no proper evidence to warrant this assertion.

The wheel of a chariot in an old Egyptian painting of a boat has often been mistaken for a paddle-wheel, and a precisely similar mistake has been made in describing one of the sculptured slabs from Nineveh; but Sir H. Rawlinson and Dr. Layard assure me, that in their Babylonian researches they have not discovered any indication of the use of machinery for propelling vessels. †

Pancirollus, who wrote in 1587, says he saw an old bas-relief, representing an Illyrian galley propelled by three wheels on each side, turned by oxen. The same author, and several others, refer to Vitruvius for a notice of the paddle-wheel; but I find, in five editions of Vitruvius, the drawings represent merely a wheel turned by the water, and used as a log to measure the speed.

Again, Claudius Codex is said to have employed paddle-wheels in the invasion of Sicily in the third century before Christ, and some MSS. in the King of France's library (which I have not been able as yet to inspect) are referred to for this statement; but after diligent inquiry I can find no confirmation of it in any accredited authority. An old work on China contains a sketch of a vessel moved by four paddle-wheels, and used perhaps in the seventh century; but the earliest distinct notice of this means of propulsion appears to be by Robertus Valturius, in A.D. 1472, who gives several wood-cuts representing paddle-wheels.

Some months ago I inspected two letters, written in A.D. 1543 by Blasco de Garay, and now preserved in the national archives at Simancas, in Spain. These give the particulars of experiments at Malaga and Barcelona, with large vessels propelled by paddle-wheels, turned by forty men. By many authors, and for a long time, it has been positively affirmed that Blasco de Garay used a steam-engine for marine propulsion, but, after careful and minute investigations at Simancas, Madrid, and Barcelona, I cannot find one particle of reliable evidence for this assertion.

After the various notices referred to, we find boats propelled by paddle-wheels mentioned by many early writers, such as Julius Scaliger in 1558, Bourne in 1578, Ramelli in 1588, and Roger Bacon, 1597.

Before we consider the application of the steam engine to turn paddle-wheels, it is well to notice briefly some of the other agencies employed.

The muscular power of men, of horses, and of other animals, was often used and frequently patented, even to the year 1848, by Miller; and 1856, by Moses. The Marquis of Worcester, in 1661, patented the application of a current, to turn paddle-wheels on a vessel which they propelled by winding up a rope. ‡ Papin, in 1690, proposed to work the wheels by gunpowder, exploded under pistons; Conrad (1709) used the force of the wind; Maillard (1733) and Goutaret (1853) applied clockwork; Harriott (1797) used falling water; weights were employed by Tremeere (1801); Congreve (1827) used the capillary attraction of a wheel of sponge on glass plates; Dundonald (1833) applied the oscillations of mercury, and Jacobi (1838) employed an electro-magnet to work the paddle-wheels of a vessel on the Neva. The whole number of English patents relating to marine propulsion is 802, from the earliest, granted to Ramsey in 1618, to those of June, 1857. §

** Read before the Society of Arts.

* The paddle-wheel propels a vessel in a direction perpendicular to the shaft, while the screw-propeller urges it in a direction parallel to the shaft.

† An old Chinese woodcut, in the late Dr. Morrison's library (at University College Library), has some resemblance to a paddle-wheel, but this also is probably misinterpreted.

‡ Chabert (1710), Drouet (1722), Pitot (1729), and Boulogne (1729), used a similar plan.

§ The information contained in this paper was collected by the writer in compiling, for the Great Seal Patent Office, the "Abridgments of the Specifications" of these patents. Parts I. and II. of this work have been published by the Commissioners of Patents, and the remaining Part will shortly appear. As the authority for every statement is distinctly given in these publications, it will not be necessary to give references here. The following statistics relate to the patents above-mentioned. Patentees resident in the City of London, 83; in the county of Middlesex and City of Westminster, 252; Surrey, 59; Lancashire, 46; Kent, 29; Hants, 19; Yorkshire, 18; Gloucester, 18; Essex, 11; Sussex, 10; Northumberland, 9; Chester, 9; Worcester, 6; Stafford, 6; Derby, 5; Nottingham, 5; Durham, 5. All the other counties have a less number, and ten of them have only one each. Patentees resident in Scotland, 45; Ireland, 20; America, 18; other foreign states, 46. Patents "communicated from abroad," 64; with two or more patentees, 66. The patentees are described by the following avocations—engineers, 273; gentlemen, 251; tradesmen, 74; naval commanders, 14; medical, 11; shipbuilders, 11; peers, 8; shipowners, 8; mariners, 5; machinists, 5; farmers, 4; architects, 4. A less number to each of 21 other professions. There are two female patentees, and the callings of 160 are not mentioned. Eighty of the patents are dated in January, 46 in August, and the other months have intermediate numbers. 305 of these patents are under the new law since 1852, and of these 110 were allowed to become void after six months.

It appears that Denis Papin, in 1690, first proposed to use steam to work paddle-wheels. A rackwork was moved by pistons descending in steam cylinders by atmospheric pressure. Savery, in 1702, scarcely ventured with timidity to suggest the use of the steam-engine for the purpose, but it is asserted in a French work that Papin, in 1707, actually propelled a vessel on the Fulda by Savery's engine.

The first patent relating to a steam-boat is that of Jonathan Hulls, in 1736. He placed a paddle-wheel on beams projecting over the stern, and it was turned by an atmospheric steam-engine, acting in conjunction with a counterpoise weight, upon a system of ropes and grooved wheels.

The Comte d'Auxiron and M. Perrier are stated to have used a paddle-wheel steamboat in 1774, but the notices of these and of other early experiments are very vague, not contemporaneous, or on doubtful authority. Desblancs, in 1782, sent a Model to the Conservatoire (still there) of a vessel in which an endless chain of floats is turned by a horizontal steam-engine.

The first notice I can find of a successful trial of the steam-boat recorded by witnesses is in a notarial certificate which I lately inspected in Paris. This asserts that in July, 1783, the Comte de Jouffroy caused a vessel of 130 feet in length to be propelled for a quarter of an hour by a steam-engine upon the Saone, near Lyons.*

Experiments conducted about the same time at Dalswinton, in Scotland, by Patrick Miller, resulted, in 1787, in the successful use of a steam-engine, by Miller, Taylor, and Symington, to propel a vessel by paddle-wheels, which worked one before the other in the centre of the boat.

The engine of this, the first practical steam-vessel, is still preserved by Mr. Bennet Woodcroft, Superintendent of Specifications at the Great Seal Patent Office, and it may now be seen at the Patent Museum in Kensington.

The *Charlotte Dundas* was built on the Clyde Canal in 1801. Although Fulton used a steamer on the Seine in 1803, and another in America, *The Clermont*, in 1807, was the first that plied so as to be remunerative in that country. In 1809, the *Fulton the First*, steam-frigate, was launched at New York. Bell built the *Comet* in 1811, at Glasgow, and used it regularly for traffic next year. In 1815 Dr. Dodd steamed from Glasgow by Dublin to London in the *Thames*, which made a stormy passage of 758 nautical miles in 121 hours.

Steam navigation was introduced into France in 1815. In 1818 Napier's steam-packets ran regularly between Greenock and Belfast. It is said that in 1819 the *Savannah* steamed from New York to Liverpool, but the assertion is very questionable. The *Comet* first carried the Admiralty pennant in 1822. In 1825 the *Enterprise* steamed from England to Calcutta in 113 days. Guns were first carried by the steamer *Salamander* in 1832†

With respect to the various positions of paddle-wheels, it will be observed that most of those in earliest use were placed at each end of a shaft across the vessel. In Hulls' plan (1736) the wheel was behind the stern. Bramah (1785), Miller (1787), and Symington (1801), placed the wheels in a passage inside the vessel open to the water. In Phillip's plan (1821) a wheel on deck turned on a vertical axis, and each float folded up to pass over the vessel. Submerged wheels on vertical axes were frequently patented. Sharples (1821) worked his wheel against the air; Harsleben (1826) placed the paddle-shaft at an angle to the horizon; Robertson (1829) and Perkins (1829) kept it horizontal, but inclined to the line of the keel, and the floats being turned at an angle in the opposite direction, entered the water in the usual way. Sharpley (1856) substituted for the wheel and floats a drum carrying a spiral rib;‡ Bellford (1853) put the engine and cargo inside a hollow drum, with floats outside, that propelled it as the drum revolved.

Having thus noticed the paddle-wheel generally, as to how it was introduced, how it was turned, and where it was placed, we may proceed to consider various plans and inventions relating to its several parts; but it is to be distinctly understood that I refrain from comparing the relative merits of these different suggestions.

Beginning, then, with the shaft and wheel, as a whole, we find that Tremeere (1801) and Robinson (1826) supported it on a stage, to be raised and lowered by ropes. For the same purpose Melville (1845) used a cogged sector, and Drake (1851) employed screws;§ Coles (1839) supported the shaft on friction wheels.

To enable the engineer to use only one wheel at a time, Gough (1828) put each on the shaft of a separate engine, while in Field's plan (1841) the wheel was disconnected by moving it and the part shaft horizontally. For the same purpose Wilkinson (1835) moved a sliding crank plate along the divided shaft, until the crank-pin locked into it. Brunet (1843) used a sliding ring and bolts; Thomas (1851) employed wedges and a friction cushion. In Seaward's plan (1840) the parts were coupled by friction surfaces, screwed up to close contact. Trewhitt (1840) tightened a friction strap by cutters; Bodmer (1843) and Borrie (1843) used cogwheels; Scott Russell's patent (1853) gearing worked by the motion of the shaft is applied to the *Leviathan*. Price (1823) used intermediate wheels to regulate the relative speed of the engine-shaft and paddle-shaft. The groove and stud apparatus of Parlour (1838) gave the wheel twice the speed of the engine-shaft.‖

The modifications of the wheel itself are difficult to classify. Barton (1820), Sang (1852), Bellford (1853), and many others, made it a buoyant drum; Stevens (1827) put floats on three arms, not in the same plane. Springs were introduced by Adams (1839 and 1855) to ease concussion. Skene (1827) had side plates on the rims. In Tayler's plan (1840) one wheel might be covered from the water by a shield. Essex (1838), by dividing the wheel horizontally, folded back one part by hinges on the rim; while in Drake's plan (1851) the arms fold on hinges, like a fan. Galloway (1832) and Herbert (1855) attached an additional wheel, by a short shaft jointed to the outer end of the other, so that the rims of the wheels approached under water, and were more apart at the upper edges. Daubeny (1840) made the second outside wheel turn slower than the inner one, but in a parallel plane.

Let us next turn attention to the floats or paddle-boards, and first as to those that are immovable on the wheel. Floats of the simple rectangular radial form were the earliest in use. Pitot (1729) put floats in planes tangential to the surface of a cylinder on the shaft; Perkins (1829) placed them at an angle to the shaft; Sharpley (1856) aggregated them into one continuous spiral rib; Galloway (1832) used two sets of floats, inclined in different directions; Chatterton (1842) and Stevens (1851) inclined each float in an opposite direction to the next, which projected beyond it at one end. Brooman (1852) put the oblique floats with one end further from the shaft than the other; Carter (1832) put a valve between each pair of inclined floats. This was to let out the back-water, which was effected in Pickworth's plan (1836) by louvre boards in the float, in Elvey's (1837) by a valve, and in Woodley's (1839) by holes bored diagonally through the float. Galloway (1835) divided the float horizontally, and put the parts successively in advance of each other. In Gemmel's plan (1837) the middle part was foremost, and Jones (1847) made the parts to overlap.

The edges of floats were curved by Robertson (1829). Ruthven (1830) made them of a barrel shape,* and there is scarcely any other form which has not been proposed for them at one time or another.†

Floats were made moveable, for reefing, shipping, and feathering. For reefing, Parr (1825) made the floats slide on the arms with joints. Galloway (1843) placed the moveable pieces on a separate inside wheel, moving laterally on a hollow shaft; and Brunet (1843) placed them on different sides of the arm.‡

Hall (1839) and Bird (1842) protruded them by a fixed spiral groove. They might be folded on hinges in Tremeere's plan (1801), and were worked through screw-rods by Holebrook (1838). In Leeming's plan (1835), and Newton's (1843), each float protruded during part of every revolution. Redmund (1831) made them fall back by hinges as they revolved. Each float ran out and in by its buoyancy in Oxley's plan (1845).

The contrivances for feathering floats are numerous. In some cases, each float turns like an oar on a spindle, radial from the shaft, as in Duquet's plan, in 1693, where they feathered by fixed tappets. This was frequently patented afterwards. Two sets of such floats were used by Oldham (1820): Stead (1828) turned them by grooved guides, and Symington (1834) by cog-wheels. But the more common method was to cause the float to feather on a horizontal axis, parallel with the shaft. Silvester (1792) effected this by a spindle turned by a fixed cog-wheel; Broomfield (1825) made the principal cog-wheel adjustable by a screw; Steenstrup (1827) and Brown (1845) used an endless chain to regulate the angles of the float; Holebrook (1832) used a spindle, with a worm at one end and a pinion at the other. Curved rims, or cam-guides, feathered the floats by acting directly on catches, in the plans of Binns (1822), Pool (1829), and Winkles (1840). Parr (1825) caused the pressure of the water to feather the float on an axis, dividing it unequally; Binns (1822) loaded the float so as to keep one edge always lowermost. This mode was repeatedly patented.§ Skene (1827) combined these two last means, and bridle-bars were added by Vint (1835). Long before this, Lambert, in 1819, kept the free edges of the floats lowermost by attaching them all to a heavy circular rim without bearings.‖ Parlour (1838) feathered the floats by a divided shaft, of which the part attached to the float-spindles turned twice for each revolution of the other part.

In 1813, Robertson Buchanan patented his invention for feathering each float by a spoke from an arm on its spindle, jointed to a rim turning on a fixed eccentric.

This application of the eccentric was repeatedly patented in various shapes, and many of the plans are so similar, if not identical, that it is evident their inventors were ignorant of what had been done before. It is to be regretted that, in many of these cases, from £300 to £500, besides often ingenuity, time, energy, and private expenditure, were thus needlessly thrown away; and it is to be hoped that, by the enlightened policy of the present authorities at the Patent Office, inventive energy will be delivered from a useless repetition of past efforts, and genius will be set free to cultivate new fields of labour.

In 1827, Oldham put the feathering eccentric on a hollow shaft, embracing the paddle-shaft, and so turned slowly, by fixed cog-wheels, as to cause the side edges of each float to point to the top of the wheel.

Bernhard (1828), Anderson (1828), and Giffard (1837), made the eccentric adjustable, so as to regulate the angles of exit and entrance of the floats.¶

---

* No description of the machinery of this vessel is given before that published in 1816 by the Marquis de Jouffroy, who gives a sketch of the steam-boat. A copy of this is in the Great Seal Patent Office Library.

† The Emperor of Japan received a steam yacht, as a present from the Queen of England, in 1858. The Chinese now use mock steam-boats, with paddles turned by men concealed inside.

‡ Both these last two methods tend to propel the vessel in a line inclined to the shaft, and, in this respect, their operation is intermediate between those of the paddle-wheel and screw-propeller.

§ The connecting-rod had a screw joint, which allowed its length to accommodate itself to the varied distances between the piston-rod and the shaft.

‖ Murdoch (1839), Brown (1842), and Bodmer (1844), had plans somewhat similar.

* Hollow floats were used by Berry (1831) to condense the steam conducted through the arms.

† Some of these variations of form will be found in the following patents:—Perkins, 1829; Gemmell, Cave, and Hall, 1837; Rennie, 1839; Rapson, 1840; Joest, 1841; Biram, Lauder, 1842; Smart, 1843; Handcock, 1844; Cartwright, Blythe, and Parlour, 1845; Barlow, 1851; Flynn, 1852; Scott, 1854; Bellford, 1855; Chatterton, 1855; Parkhurst, 1856; Crooker, 1857.

‡ Massie (1836), dividing each float into parts with parallel bars, caused one set to move over the other for reefing. For attaching the floats, Hamond (1844) used wedges, while screws were employed by Brown (1847).

§ Mercy (1825) tried to make the float feather by buoyancy, and Hill (1825) connected all the floats together by forked jointed pieces.

‖ Cochrane patented this ten years afterwards, and Napier did the same in 1841; Miller (1848) added small guide rollers to steady the rim and increase the vertical pressure.

¶ This is done by levers, or by a sector working a framework jointed to the rods that work the floats.

In Lagergren's plan (1855), the rim on one side was higher than that on the other, and each float revolved on horizontal bearings, placed at its diagonal points.

Pickworth (1836) made each feathering float to consist of a frame carrying louvre boards on vertical spindles.

In Bramwell's plan (1851), an eccentric motion and springs caused the arm and float to yield at the beginning of the stroke, and to work at greater angular velocity near the end. Ross (1856) gave to the outside edge of hinged floats a similar variable motion. The paddle-floats of the *Leviathan* do not feather.

Among the few patents relating to paddle-boxes, we may notice Cochrane's (1818), for forcing smoke from the furnace into a closed paddle-box partly submerged, so as to exclude the water. Palmer (1839) did this by pumping in air, while Taylor (1848) allowed it to be forced in by the waves. Symington (1835) led the spray from the paddle-box to cool the engine; and the well-known paddle-box boats were patented by Smith in 1838.

We must go back again to early times for the first appearance of the screw propeller. It is probable that, as the action of a watermill suggested the use of the paddle-wheel, so the motion of a windmill may have prompted the use of the oblique vaned propeller.*

In 1729, Duquet submerged an apparatus like a smoke-jack or windmill, and the action of the stream turned its shaft so as to wind up a rope.

In 1746, Bouguer states that "revolving vanes, like those of a windmill," had been tried for the propulsion of vessels; but it is not clear that the axis was turned by force inside the vessel, or that the method was an advance on that of Duquet.

The use of the screw propeller in China may be of an indefinite antiquity. A model of one was brought from that country about the year 1780. It had two sets of blades, turning in opposite directions; but the first distinct description of the screw propeller, to be turned by machinery inside a vessel, seems to have been by D. Bernouilli, of Groningen, in 1752; and it is remarkable that this, though the earliest recorded proposal, was well enough matured to comprise the use of oblique vanes at the bow, sides, and stern, turned by a steam-engine, and capable of being hoisted out of the water. The woodcut representing the inventions of Bernouilli is copied from one published A.D. 1803, in "Annales des Arts et Manufactures," Tom. 20, Pl. II., p. 100.

In 1768, Paucton proposed the pterophore, a screw thread on a cylinder, to be wholly or partly immersed. In 1770, James Watt suggested to Dr. Small the trial of a steam screw-propeller; Bramah, in 1785, first patented a rotary engine for this purpose; Ramsey (1792) put the screw between two hulls; and Lyttleton (1794) used a three-threaded screw, while Fulton (1798) tried one with four blades. Shorter's screw (1800), with a jointed shaft,† and worked by men, was applied in 1802 to H.M. ships *Dragon* and *Superb*. The first screw-steamer I can find was tried by Stevens in America‡ in 1804. In 1825, Brown used one on the Thames.

The only patent for combining the screw-propeller and paddle-wheel is that of Turck, in 1852. The *Bee*, a naval steam-tender at Portsmouth, has carried both paddles and screw since 1842, but they are not worked together.

Screw propellers are so various in form that we can scarcely arrange them for consideration according to their shapes or modes of action.§ It will be better to group the inventions according to the several parts of the apparatus they relate to. And first, with respect to the general arrangement of the whole apparatus, there is scarcely any position under or above water all round the vessel which has not been proposed for the screw-propeller; indeed, most of these varieties of position were exhausted by the earliest plans.

The first English patent relating to the subject is Miller's, in 1775. Here the blades are at the end of the arms of a windmill on a vessel's deck, with its axis parallel to the keel. Duncan (1851) put the blades on an endless strap, running outside over the deck and round the hull. He suggested also (1856) that a spiral rib, wound round a floating cylinder, should act for propulsion as the cylinder is caused to turn.||

Bernouilli and Shorter, having suggested propellers at the bow, sides, and stern of a vessel, Cummerow, in 1828, placed one in an opening in the stern deadwood, which is now the usual position.

Taylor, again (1838 and 1846), using two propellers on separate shafts, brought them so near that the blades overlapped and passed between each other. Napier (1841) placed one of the approximated propellers astern of the other. Carpenter (1851) put two propellers in separate stern-pieces. Bucholz (1851) had three of them, and placed the middle one astern of the others. In all these cases the shafts were on the same level, but Tombs (1856) placed the shaft of one (the aftermost overlapping propeller) a short distance above the other shaft, to which it was geared,* so as to turn in an opposite direction.

Next, we must notice different propellers on the same axis. Perkins patented the plan† in 1824, placing one shaft within the other, and turning the screws in opposite directions. Church patented it in 1829, and Ecrisson in 1836, when a hoop with short vanes was used, instead of blades.

Such were the positions of the propeller when in use; but it was soon found needful to have a power of altering the position, so as to hoist it out of the way. For this purpose, Bernouilli (1752) put hinges on the rods, supporting his side propellers, and detached the propeller from the shaft at the stern.‡

In Shorter's plan (1800) the shaft had a universal joint, which allowed the propeller to be raised: Pumphrey (1829) detached the propeller at this joint; Taylor (1838) disconnected the shaft by drawing inwards the engine part, so that the propeller could be raised in vertical guides; Maudslay (1846) used a similar plan, and screwed one part of the shaft into the other to connect them again; Galloway (1843) and Griffiths (1853) disconnected the whole apparatus by chains, which extricated the shaft from the bearings successively; Seaward (1846) lifted the propeller by rods which were screwed into the boss.§ The propeller was raised in a different manner by Perkins (1845) and Tucker (1850), who put it on an arm turning vertically round a horizontal pin above the shaft.

Some other inventions relating to the propeller shaft may be briefly noticed. Thus, Buchanan (1846) supported the shafts on springs. Montgomery (1846) and Hunt (1854) made it yield to a twisting strain. Wimshurst (1850) and Prideaux (1853) inserted a dynamometer between its parts. Blaxland (1840) put the shaft on a single spherical bearing, so that its inner end could be raised.

Various plans were suggested for receiving the horizontal thrust of the shaft. Hays (1844), Buchanan (1846), and Prideaux (1853), received the end of the shaft in a water-box; Penn (1845) upon a steel plate, revolving so as to present new surfaces to the point; Beale (1848) deflected part of the thrust along other transverse shafts by bevilled wheels. A common groove and furrow bearing is used in the *Leviathan*. Penn (1854) put wood to work on metal for the bearings under water; Buchanan (1854) placed two shafts one above the other, and the propeller could be attached to either as the vessel was loaded; Napier (1856) worked the propeller shaft at different elevations by an adjusting vertical shaft and cog-wheels; James (1857) pumped water through it to be discharged at the ends of the blades, and thus to turn them.

To regulate the speed of the shaft, Galloway (1843) had a multiplying gear of bands and wheels. Maudslay (1843) used drums and an endless rope. Hays (1844) inserted an additional shaft and cog-wheels, while Griffiths (1849) applied the sun and planet motion. Robertson (1856) used grooved friction wheels, and Struthers (1856) geared one shaft to the other by a cog-wheel with internal teeth. Bodmer (1844) caused the propeller to turn with a velocity alternately increasing and decreasing. Hunt (1854) connected the shaft with the throttle-valve, so that the steam was regulated by the degree of pitch of the blades; Roberts (1851) made the box much larger than usual; and Griffiths (1849) tapered its after end to a conoidal point, and other forms of the box were applied in connection with moveable blades.

The forms proposed for propeller blades, both for outline and section, are innumerable. It is hoped that in noticing only a few, no injustice will be done to the other twists aud curves and fanciful forms, so many of which remain unknown to fame.||

We shall direct our attention first to blades not moveable on the shaft. In 1825, Marestier had a screw of a "helicoidal surface." Woodcroft (1832) patented a propeller with an increasing pitch;¶ Smith (1836) used two threads of a half turn each at the ends of a diameter.

In the plans of Lowe (1838) and Borrie (1843) each blade revolves in a different plane. Haddan (1839) fixed two spirals at a distance from the shaft; Poole (1848) patented the "Bommereng" propeller, in which a bent blade turns about its centre of gravity in the shaft; Joest (1841) shortened every alternate blade; Dundonald (1843) bent them towards the stern; Griffiths (1849) towards the bow, or alternately each way.

Samuda (1843) put the blades projecting inwards from a hollow drum. The surface they presented was made elastic in the plans of Duncan (1816), Macintosh (1847), Hendryckx (1850), and Hunt (1854). Oxley (1845) made it expansible by wedge pieces. Amongst other forms were Sunderland's (1843), and Southworth's (1846), bounded by areas of circles; Griffiths' (1849), open in the centre, or with blades like lancets,** and Lowe's (1852), with an indescribable twist.

The blades were made moveable on their radial axes in the boss by Millington, in 1816.

Woodcroft (1844) effected the adjustment by a rod lying along the shaft, jointed at one end to a short arm on the blade, and carrying at the other end a

---

* The windmill is of an unknown antiquity. There is an interesting description of it by R. Hooke, in 1681. It will be observed that under the term "screw propeller" we include every rotating propeller with oblique vanes which urges the vessel in a direction parallel to the propeller shaft.

† Patented again by Phipps, 1850, with a moveable outside bearing, and by many others.

‡ Worked first by a rotary engine, afterwards by Watt's reciprocating engine. In this year, 1804, Boaz made experiments with the screw. The following information is extracted from the Board of Trade papers:—Total number of steam-vessels registered up to January 1, 1857, 1,668, of which there were wooden, with paddle-wheels, 820; with screw propellers, 19; total of wood, 839. Iron, with paddle-wheels, 356; with screw-propellers, 473; total of iron, 829. From the Navy List we learn that there are at present, in the Royal Navy, wooden steamers with paddle-wheels, 67; with screw-propeller, 160; and 185 gun-boats. Iron steamers with paddle, 15; with screw, 10; with both paddle and screw, 1. Total number of war-steamers, 427, carrying about 16,000 guns, and of 86,000 H.P. In 1814 there were only 2 steam vessels belonging to the British empire. These had increased, in 1855, to 2,010, of 408,290 tons. The number of steam-vessels has doubled since 1845, and their tonnage increased threefold. The first iron steam-vessel was made in 1822. In 1856, 54 wooden and 175 iron steam-vessels were built (tonnage, 57,573), and 35 of both kinds were wrecked. Within the last twelve years about 20 large mail packets have been lost. Since 1853, 2,000 persons have perished, and ten millions of dollars' worth of property have been destroyed in the wrecks of the United States coasting mail packets.

§ A general division may be made into two classes. In one (as in the plans of Bernouilli and Bouguer) no thread continues through an entire revolution. In the other a helical thread has at least one revolution (as in the plans of Duquet and Paucton).

|| A similar mode of propulsion used by an insect is noticed near the end of this paper.

* Morrison (1854) placed one propeller "above the other."

† The Chinese propeller seen by Col. Beaufoy, in 1780, had two screws turned in opposite directions, but they may have had separate axes. The plan of Perkins was patented afterwards by Smith (1838). Dugdale (1849) put several propellers on the same shaft.

‡ Others left the propeller free to revolve as the vessel sailed. Slaughter (1849) helped it to do so without resistauce by a "donkey engine."

§ Wimshurst (1850) used a similar plan, and disconnected the parts by withdrawing bolts; Wilson (1852) caused the propeller to be hoisted by screwing itself along the inclined shaft; Oxley (1845) enclosed the space occupied by the propeller (when at rest vertically) with water-tight doors, in a chamber kept dry by compressed air.

|| The propeller blades of the *Leviathan* are fixed, and of a common form.

¶ A right-angled triangle, wound upon a cylinder, traces a screw by its hypothenuse. When a spiral curve is put instead of the hypothenuse, the screw will have an increasing pitch. Fraissinet (1838) used a parabolic curve, and Rennie (1839) applied another curve. Beadon (1845) and Templeton (1846) made the blades of a volute form; Rosenberg (1845) reversed the usual curvature by making the blade near the boss parallel to the shaft.

** Griffiths (1849) proposed to determine the best form of curved blade by using balls floating in the wake of the propeller, so as to indicate the forces acting at different points by spring balances.

stud, which takes into a groove in a short box or hollow piece, traversing the shaft on feathers.*

Woodcroft, in 1851, used another form of box, by which the blades could be so turned on their axes, while the shaft revolved, as to operate on the water with their reversed sides, and thus to back the vessel without stopping the engines.

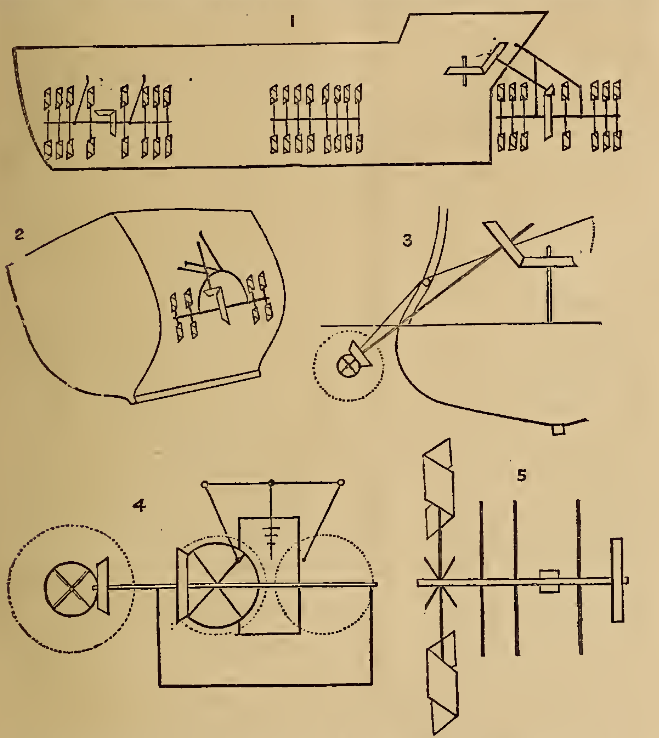
Hays (1844) altered the blade's angular position by screwing up a ring. Bodmer (1844) placed one pair of blades loose on the shaft, so as to be properly set as they revolved, and to rest vertically behind the false stern-post. For the like purpose, Malo (1850) put the pairs of blades on different shafts, one being hollow.

Buchanan (1846) made the water turn the blade on its radial axis, and fixed it by clutches.†

Wingate (1857) turned the blade by a key, and fixed it by the friction of its conical shank in the boss.

In 1849, Griffiths caused the pitch of the blades to be altered by levers, according to the speed of the shaft. Burch (1852) substituted a large plate for the boss, and the blades thus projected beyond the ordinary full lines of the stern, which were continued aft beyond the propeller. Paterson (1857) produced a similar effect by using for the boss a large conical drum, coinciding at the foremost end with the shape of the vessel, which was terminated by a round vertical plane.

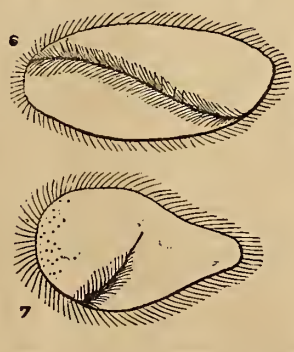
The screw propeller was caused to steer the vessel by altering the direction of the shaft, or the angular position of the blades. Shorter (1800) and Wellington (1816) used the first plan, turning the shaft to one side or another by a Hooke's joint. Pumphrey (1829), Buchanan (1853), and Abadie (1854), attached the shafts to a frame moveable laterally with the rudder; and Bucholz (1851)



geared each of his three propellers in a ring, which allowed the axis to be directed for steering.

The second mode of steering was adopted by Woodcroft (1851), who attached each blade by an arm to a rod with a stud in the groove of a box on the shaft inside the vessel. The direction of the groove could be so altered by switches as to cause the blade to act with its broadside during one part of each revolution, and thus to impel the stern to one side or another. When the blades were stationary, in a vertical position, they might be turned on their axes, so as to act like an ordinary rudder.

Foulevton (1844) and Wimshurst (1850) placed a screw on an axis athwart the vessel, so as to steer by revolving in one or the other direction.



* A full-sized model of this plan is placed in the Patent Museum, at Kensington. In 1851, the same patentee used a hollow shaft with a cog-wheel acting on a pinion on each blade. The plans of Hays (1845) and Brown (1847) were nearly similar.

† Griffiths (1853) adjusted the blades from the deck by a key working a bolt in the boss.

In the modes of propulsion adopted by aquatic animals may be found almost every plan which has been used by man with machinery. Thus, water is ejected for propulsion by the cuttle fish and "paper nautilus;" sails are used by the velella and water birds; punting and towing by whelks and the lepidosiren; a folding paddle by the lobster, feathering paddles by ducks, and oblique surfaces by fish of all kinds. A screw-like appendage is found in the wings of an Australian fly, but it is supposed to be shaped thus only when dried after death. There is, however, one remarkable animal which propels itself by a rotary movement, acting on the water by means very similar to those of the paddle-wheel and screw-propeller combined. This is the infusorial insect Paramecium. My attention was called to this miniature *Leviathan* by Mr. Robert Mallet, and after some months of ineffectual search I was fortunate enough to see its operations distinctly in one of Mr. Tomkins' splendid microscopes. The form is represented in the accompanying woodcut. A sulcus or furrowed groove runs obliquely round the oval-shaped body of the animal (in one variety it is only near the stern). A wave-like protuberance passing along this sulcus (with or without cilia) causes the body to rotate on its longer axis, and thus propels it as by the fore and aft stroke of a paddle, as well as by the screw-like progress induced by the spiral groove.

The coloured diagrams around us show, without verbal explanation, the gradual progress of marine propulsion from the early days of Nineveh, Babylon, and Egypt. We have traced its more particular application in the rotatory action of the paddle-wheel and screw, and have seen these combined in one of Nature's smallest works. Let us hope that the giant vessel now afloat will be a great success, bearing forth our sturdy emigrants to lands of plenty—honest English hearts to shores of commerce—strong hands to works of industry—strong minds to stores of knowledge—brave armies to fields of glory—and the gospel of peace to the ends of the earth.

ON THE PROGRESS OF THE ELECTRIC TELEGRAPH.

By C. W. SIEMENS, C.E.*

THE growing importance of the electric telegraph, both in a scientific and social point of view, and the circumstance of my connection for a good many years with its practical development, are the apologies I have to make for venturing to occupy the attention of the Society this evening.

The object which I have more particularly in view is to trace the gradual course of progress of this invention since the time of its first appearance upon the stage, without pretending, indeed, to establish any new historical facts, or to decide upon the relative merits of contending claimants to invention or discovery (although I shall not willingly offend against the right of anyone), but with a view to establish more clearly our present position in the scale of progression, and to point out, with some degree of certainty, the direction in which we should travel, in order to realise still greater results, particularly the accomplishment of trans-oceanic communication.

When, little more than a century ago, Franklin, the father of electrical science, ascertained that atmospheric electricity, which manifested itself in the imposing form of thunder and lightning, was identical with frictional electricity, he employed an apparatus comprising an insulated metallic conductor, the electric machine, the earth return circuit, and a receiving instrument, consisting of a pair of cork balls, suspended by silk threads, which, upon being electrified, struck against a pair of signal bells. This apparatus comprised, indeed, all the elements required for the construction of a modern electric telegraph. Nor was the idea of an electric telegraph new even in the days of Franklin, for we are informed that as early as the year 1728 a pensioner of the Charter House, named Stephen Grey, made electrical signals through a suspended wire 765 ft. long. Yet a century of unceasing efforts, by men of all civilised nations, including some of the greatest natural philosophers the world ever produced, was still required to reduce those elements into available forms for practical purposes.

If we pass over the experiments by Winkler, of Leipzig, in 1746, Watson, of London, and Le Monier, of Paris, in the year following, as preliminary inquiries into the velocity of the electric current in metallic conductors, we find that the honour of having produced the first electric telegraph is due to Lesage, of Geneva, who actually constructed, in 1774, an experimental line of communication, consisting of 24 suspended line wires, representing the 24 letters of the alphabet respectively. Each wire terminated in a pith ball electrometer, the balls of which separated, upon the wire in question being charged at the other extremity by means of a Leyden jar, denoting the letter intended to be communicated. Lomond, of France, perceiving the difficulty and expense attending so many line wires, contrived, in 1787 (see "Young's Travels in France," 1787), an experimental line of telegraph in his house, consisting of only one line wire connected with a pith ball electrometer at both ends, and he proposed a telegraphic code by repetitions of his only primitive signals. Reisser, Dr. Salvo, of Madrid, and many others, proposed various modifications of the same apparatus, but it is hardly necessary to add that all of them remained unrewarded by success.

In consequence of so many fruitless attempts, electric telegraphs were already being classed among the chimerical projects of the time when, at the dawn of the present century, a new field for invention was opened by the important discoveries of the Italian philosophers Galvani and Volta.

The voltaic current, unlike the spontaneous discharge of static electricity, could be conducted with comparative facility through long metallic conductors, and was capable of very powerful effects in decomposing water or other substances, which qualities rendered it clearly preferable for telegraphic purposes.

Struck by these views, Soemmering, of Munich, constructed, in 1808, the first voltaic telegraph, consisting of 35 line wires, any two of which could be

* Paper read before the Royal Society of Arts.

combined to form the electric circuit, and produce a signal at the other extremity by decomposition of water under any two of 35 inverted glass cups, arranged side by side in an oblong bath of acidulated water. The 35 wires terminated in gold points, under the inverted glass cups (or voltameters), and the rising of the gases of decomposition betrayed to the attentive observer the passage of the current.

The difficulty of dealing with so many wires suggested to the mind of Schweigger the same expedient which Lomond had recourse to with regard to static electricity, that of reducing the number of line wires to a single metallic circuit, and the receiving instrument to a single decomposing cell, having recourse to repetition, and to differences in the duration of succeeding currents, in arranging his telegraphic code.

It seems not improbable that if electrical science had made no further advances, the projects of Soemmering and Schweigger would have gradually expanded into practically working chemical electric telegraphs, such as have been proposed at a much later period by E. Davy, 1838; Morse, 1838; Bain, 1843; and Bakewell in 1848, which latter is particularly interesting, inasmuch as not mere signals or conventional marks are received by it, but a facsimile of the message, written with a solution of shellac upon a metallic surface.

The discovery of Oersted, in 1821—which, under the hands of Schweigger, Ampère, Arago, and Sturgeon, soon expanded into electro-magnetism—turned the tide of invention into quite another direction. Ampère was the first to propose an electro-magnetic needle telegraph, consisting of 24 needles, representing each a letter of the alphabet, and 25 line wires, the extra wire being intended for the metallic return circuit common to all. Ritchie executed, in 1832, a model of Ampère's telegraph, with an essential improvement, to the effect that each needle by its motion moved a screen disclosing a letter of the alphabet.

Another version of the same general arrangement was patented by Alexander, of Edinburgh, as late as 1837. Fechner, of Leipsig, and Shilling von Canstalt, of Russia, proposed, in 1832, apparently independently of each other, a single-needle telegraph, with deflection of the needle to the right and left; and Fechner was the first to prove by calculation the power of the galvanic current to traverse a great length of line wire.

Gauss and Weber, of Goettingen, took up the subject of electric telegraphs at about the same time, but had not proceeded far when their attention was diverted by the great coming discovery in electrical science—I mean the discovery of induction and of magneto-electric currents by Faraday, in 1831.

Gauss and Weber rightly judged the superiority of magneto-electric over voltaic currents for telegraphic purposes, and in applying them they effectually established the first working electric telegraph in 1833, with the arrangements of which I became practically acquainted some years later, when a student at Goettingen.

It consisted of a line wire and return current wire, the former of which was carried upon high posts over the town of Goettingen, extending from the observatory to the tower of the public library, and thence to the new magnetic observatory of Weber, a distance of little more that an English mile. The magneto-electric current was produced by means of a coil containing 3,500 turns, which was situated upon a compound bar magnet, weighing 75 lbs., the coil being at liberty to slide freely to and fro upon the bar. In sliding the coil rapidly from the centre toward the south pole of the magnet and back again, a succession of two opposite currents was produced, which, traversing the line-wire circuit, including coils of the receiving instrument, caused a short jerk of the needle, say to the right and back again, whereas the deflection of the needle would be to the left when the exciting coil was moved towards the north pole and back. The amount of motion imparted to the coil determined also the amount of deflection of the needle, and could be read off in degrees on a reflector attached to the end of the needle by means of a telescope and a scale. The needle itself weighed 100 lbs., and was suspended from the ceiling of the room by untwisted silk. Notwithstanding the extraordinary weight of the needle (which was the same as used by Gauss to determine the laws of terrestrial magnetism) its motions were beautifully energetic and distinct when viewed through the telescope. Gauss and Weber did not pretend, however, to the construction of a commercially useful electric telegraph, but delegated that task to Steinheil, of Munich, who enjoyed already at that time a reputation as a skilful mechanic. Steinheil applied himself vigorously to the task, and produced, in 1837, his needle printing and acoustic instrument, which he first tried at Munich through about 5 miles of suspended line wire, and shortly afterwards upon the Taunus Railway, near Frankfort. In trying whether the rails might not be used for metallic conductors, he re-discovered the conducting power of the earth itself, which, it appears, had been lost sight of since it had first been discovered by Franklin with regard to static electricity, and proved also with regard to voltaic electricity, in 1803, by Erman, Basse, and Aldini.

The first recording instrument, and the telegraphic earth current, are discoveries which entitle Steinheil to a high position among the originators of the electric telegraph, although the means he proposed for its execution were too refined for the time, and did not lead on that account to immediate practical results.

At the time when Steinheil was absorbed in his labour, Professor Wheatstone was also engaged upon a series of experiments on the velocity of electricity, with a view to the construction of electric telegraphs, and in June, 1837, he joined Mr. Cooke in a patent for a needle telegraph of five line wires (besides one wire for the return current), and as many needles, which, by an ingenious system of permutations, could be so deflected that any letter of the alphabet was pointed out upon a diamond-shaped board by the convergence of two needles towards it. The line wires were proposed to be coated with insulating material, such as fibrous substances saturated with pitch, and to be drawn into leaden pipes, in order to exclude the moisture of the ground into which they were intended to be laid. An experimental line of telegraph on this principle was established in the same year at the Euston Railway Station, and the results obtained left, it appears from documentary evidence, no doubt upon the mind of the then resident engineer of the London and Birmingham Company, the present Sir Charles Fox, of its ultimate success. That success, however, was not obtained without a struggle against practical difficulties, in the course of which the system underwent important modifications, of which the double-needle instrument, such as is still used extensively in this country, and (in 1843) a return to overground line wires, were the results.

To Cooke and Wheatstone is due the credit of having established the first commercially useful lines of electric telegraph, namely, the lines between Paddington and Drayton, commenced in 1838, and between London and Blackwall, commenced in December, 1839, which were soon followed by others.

If viewed from our present position, the needle telegraph cannot be considered an advance, in point of principle, on Gauss and Weber, or Steinheil: it involved, in fact, a return from magneto-electric to voltaic currents—from a single-line wire to several, and from recording of messages to their mere indication; yet, for the time being, when insulation was imperfect, and the important law of Ohm was hardly understood by a few natural philosophers, it had the probability of success in its favour, because the duty required from the electric current consisted in deflecting a magnetic needle to a merely appreciable extent, and it was of no great importance to the result whether a more or less considerable proportion of the current was lost through imperfect insulation. The upright weighted needle, the key with dry metallic contacts, and other details, were also of a novel and meritorious character. Why the same system should, however, be still persisted in at the present day, in this country, when improved systems have been adopted in nearly all other countries, including the British possessions, is a question which, I hope, will receive an answer from those who practically uphold it. It is evident, however, that Wheatstone did not intend to stop there, from his numerous other inventions, which followed each other in rapid succession, and amongst which his dial and printing instruments—his early applications of magneto-electric currents—the relay—and the first judicious application of electro-magnets, so as to obtain more powerful effects at distant stations, are the most remarkable.

The country of Franklin has not been behindhand in gathering the first fruits of electrical science. It is said that Morse contemplated the construction of an electric telegraph since the year 1832, although he did not take any overt step till the year 1837, when he lodged a caveat in the American Patent Office, which patent was not enrolled till the year 1840. There is no evidence to show that Morse's early ideas had assumed any definite shape until the year 1838, when he deposited an instrument of his construction at the Paris Academy of Sciences. Morse's invention consists chiefly in the substitution of electro-magnets for needles in the construction of a recording instrument, which, in other respects, is similar to Steinheil's. The step was, however, an important one to render the instrument powerful and certain in its action, and, combined with the relay, Morse's recording instrument will, it may be safely affirmed, be used universally for all except local telegraphic communication.

In the year 1845, when the practical utility of electric telegraphs had been demonstrated in England, several continental governments determined upon their establishment. The Belgian, Austrian, and, a few years later, the Sardinian Government, simply adopted the double needle telegraph. In France, Messrs. De Foy and Breguetfils contrived a double step by step or dial telegraph, on Wheatstone's principles, which enabled them to imitate the same code of signals which had been used for the Semaphore telegraph.

In Prussia, a royal commission was appointed to consider and advise upon the system to be adopted, of which commission my brother, Werner Siemens, who had been engaged before with kindred subjects, became the most active member. The commission was in favour of an underground system, and charged Werner Siemens to institute experiments. About this time, gutta percha had become known in this country, and having been struck with its peculiar plasticity, I forwarded my brother a sample, to see whether he could use it for the purposes he had in view. He soon discovered its remarkable insulating properties, and recommended an experiment on a large scale, which having been sanctioned, he completed a line of from 4 to 5 English miles (between Berlin and Gross-Beeren) successfully in the summer of 1847. The machine he designed for covering the copper wire with gutta percha is nearly identical with the cylinder machine still used for the same purpose. In the spring of 1848, a considerable length of gutta percha coated copper wire was submerged in the harbour of Kiel for military purposes, but it was found that, owing probably to the impurity of the material, the gutta percha underwent a gradual change, as though it was penetrated by the sea water, to counteract which Werner Siemens proposed, with apparent effect, to mix a small proportion of sulphur with that substance. In the same and following year, more than a thousand miles of gutta percha coated line wire was laid down underground, and proved successful for several years, when it began to fail, for the most part in consequence of the impure and adulterated condition of the material then supplied. Although the underground line wire has, for the most part, been superseded again by the suspended wire, I venture to assert that we shall eventually return to it for all principal lines, for reasons which I shall enumerate hereafter. The experience gained in this great experiment has been most valuable in paving the way to submarine cables, which, at the present time, occupy so large a share of public attention.

The instruments which Werner Siemens at first proposed, and which are still used extensively on the Continent for railway purposes and town service, were dial instruments, involving a peculiar principle, inasmuch as no communicating instrument or any clockwork is employed, but the two or more instruments, connected by the single line wire, break and restore the electric circuit by the action of their own armatures, in a similar way to a steam engine, which alternately intercepts and restores the communication with the boiler. In arresting the ratchet wheel of any one of the instruments within the circuit by depression of a key, bearing a certain letter of the alphabet, the armature of the instrument in question is prevented from restoring the electric circuit, and the hands upon the dials of all the instruments in circuit must stop, pointing all of them to the same letter until the depressed key is again released. The

advantages of this arrangement over previous dial instruments are that the communicating instruments are less liable to fall out of step, and that considerable power of action is obtained, because the batteries of all the intermediate and end stations act in concert, being all included in the general circuit. The dial instrument is in some instances accompanied by a type-printing instrument, differing from Wheatstone's and Hause's arrangements, inasmuch as it is entirely self-acting, the motion of the type wheel, of the paper, and even of the hammer striking the blow upon the type, being effected by electro-magnets, instead of clockwork, or of an air cylinder, as is the case of Hause and Brett's arrangement.

Since the time of the first successful introduction of the electric telegraph, a great variety of instruments, insulators, and other appliances, have been proposed, amongst which the chemical recording instruments of Bain and Bakewell, the modifications of Wheatstone's magneto-electric needle, and dial instruments by Henley and Stoehrer, the various combinations by Messrs. Highton, Clark, and Bright, and the more recent productions of Mr. Varley and Mr. Whitehouse, are of undoubted merit in having contributed to the general progress of electric telegraph engineering. To describe them here would be a task far exceeding the limits of this paper, and I shall, therefore, proceed at once to point out what, in my opinion at least, supported by actual experience, are the best means to be adopted at the present time for extedning the electric telegraph, both on land and across the seas.

The foregoing sketch of the gradual development of the electric telegraph, may serve to show that the particular arrangements adopted to indicate or register the message, or the particular combination of elementary signs, is of secondary importance, but that every essential progress is marked by the discovery of some new means of generating currents of greater dynamic power, or of producing by their means more decided effects at the further extremity of the conductor.

Let us inquire, then, what are the conditions of current generator, current conductor and receiver, best calculated to realise a maximum of palpable effect at great distances.

Inquiry into these questions is of particular interest at the present time, when great efforts are being made to extend telegraphic communication across the Atlantic and Indian oceans, distances far exceeding the length of any land lines yet constructed.

Among the different varieties of electricity hitherto applied to telegraphic purposes, that produced by friction possesses the greatest tension or power to overcome resistance in the conductor. But its discharge is instantaneous, and it is, therefore, ill-suited to produce dynamic effects with time or duration for a factor.

The voltaic current, on the contrary, may be considered as absolutely continuous, and, therefore, as best suited to produce powerful effects, but it is deficient in tension, unless a great number of elements are employed, in which case it becomes expensive and troublesome. A battery of sufficient intensity to convey an effect through the Atlantic cable, would have to be composed of at least 500 Daniell's cells, according to ordinary practice, but I apprehend that the internal resistance of such a battery would of itself annihilate its presumed power, and that practically no battery of sufficient power could be constructed.

The magneto-electric currents hold an intermediate position between the two just referred to. Their intensity can be increased almost indefinitely, and they are of a perceptible duration (the time required to charge an electro-magnet). They may be produced by mechanical agency, on separating a permanent magnet from its armature or surrounding coils, or by means of a voltaic quantity battery and primary coils; and are, in both instances, by far the cheapest and least variable description of electric currents. The reason why, since the discovery of magneto-electricity in 1831, it has again and again been abandoned in favour of battery currents, may be traced to the imperfect means hitherto known or adopted for its generation or suitable application; but I hope to prove hereafter that it can be employed at present with perfect success.

Regarding the electric conductor or line-wire, this is either suspended upon poles in the open air, or it is imbedded in gutta percha and interred or submerged. Suspended line-wire generally consists of galvanized or painted iron, of from one-eighth to one-fifth of an inch indiameter, and supported at intervals of from 50 to 60 yards from posts by means of insulators. The construction of a really efficient insulator has for many years occupied the serious attention of electrical engineers, for upon it chiefly depends the permanent efficiency of the line. A great variety of insulators have been tried, some of which I am enabled, by the kindness of the Electric Telegraph Company, to present to the meeting. In my own experience, I have found the insulator of Siemens and Halske, which is now very generally adopted on the continent, to combine the desiderata of strength and insulating property in the highest degree. It consists of a cast-iron bracket, assuming the form of an inverted bell, with a cylindrical recess at the bottom. A capsule of porcelain is firmly cemented, by means of sulphur mixed with caput mortuum, into the recess, and into this again a stalk of iron is cemented, which, forming a peculiarly twisted loop at the end, supports and secures the line-wire. The insulating property depends upon the dryness of an apron-like extension of the porcelain capsule, which, under the protection of the cast-iron ball, is not affected by either rain or dew. Every tenth support is a stretching-post insulator, at which the line-wire is not only supported, but held firmly by means of claws, an arrangement which has been found very convenient during the erection of the line-wire and in case of repairs. An idea of the importance of a good insulator may be formed from the fact, that the cost of finding and repairing a single defect of the line-wire, in a country like Russia, amounts on the average to £30.

We now approach the subject of submerged conductors, which, at the present time, engrosses the attention of electrical engineers, and also commands a large share of public interest, owing both to the difficulties with which it is surrounded, and the vast importance of the object in view.

Regarding the history of submarine cables, it appears that the first experiments, on a small scale, to submergé an insulated conductor (copper wire, coated with cotton thread, saturated with pitch and tar), were made at Calcutta, in 1839, by Dr. (now Sir) William O'Shaughnessy.

Professor Wheatstone proposed, in the following year, to establish a telegraph cable between England and France, and prepared very elaborate and well-considered plans, which, by his kindness, I am enabled to place before the meeting. The cable Wheatstone proposed contained six separately insulated copper wires, which were protected by a strong sheathing of iron, differing, however, from the sheathing now generally adopted in being devoid of strength in a longitudinal direction.

Submarine telegraphs must, however, have proved impracticable but for the timely discovery of gutta percha, and of its remarkable insulating properties. It is, therefore, not surprising that the first successful attempts to establish sub-aqueous conductors were made by Werner Siemens, in 1848, in the Bay of Kiel, and in crossing the Rhine at Cologne, and other rivers.

The gutta percha coated copper wire was at first submerged without outer protection, but it was laid by the side of a strong chain to protect it from anchors. In the following year, however, a lead coating was introduced.

The first attempt to establish a sub-aqueous conductor across the open sea (from Dover to Calais) was made by Wollaston, in 1851. It consisted of a gutta percha coated copper wire, without external protection, and failed immediately after it had been laid. In the same year, Crampton laid a cable between the same places successfully. This cable was sheathed with iron wire according to Messrs. Newall and Co.'s patent process, which gives great longitudinal strength, and has been generally adopted ever since, except in the instance of the Varna-Balaclava cable (laid by Messrs. Newall and Co. in 1854), which had no sheathing, excepting at the shore ends, and which worked successfully for a considerable time.*

It would be tedious to notice the numerous successful and unsuccessful attempts which have been made since the year 1837 to establish submarine cables; suffice it to state the general results of the experience obtained, which goes to prove that the difficulty of submerging and working submarine cables is small in shallow and narrow waters, but increases in a very rapid ratio with the depth and breadth of the ocean to be traversed.

An inquiry into this most interesting subject may be divided into three sufficiently distinct heads—namely, the mechanical problem of constructing and submerging the cable; the electric condition of the submerged cable; and, lastly, the question of suitable instruments.

The mechanical problem has been discussed lately at great length at the Institution of Civil Engineers. I therefore propose to limit myself to a recital of the principal point of interest, which may be considered as established both by theory and in practice.

The cable should be of small specific weight and of great tensile strength, in order that its descent through the water may be retarded by the resisting medium to such a degree that the velocity of maximum acceleration may not exceed one-fourth, or, at most, one-third, of the velocity of the vessel. This condition of a "balanced cable" being fulfilled, there remains the tendency of the cable to slide down the inclined trough of the water, and it has been proved that this force equals, under all circumstances, the weight of a length of cable (less the weight of water it displaces) reaching from the vessel perpendicularly to the bottom of the sea. The same amount of retarding force must at least be applied to the paying-out brake, to prevent great waste of cable, and the cable itself must, of course, be sufficiently strong to bear this strain without injury to the insulated wire or wires.

Messrs. Longridge and Brooks have been the first to prove, I believe, that currents in the ocean cannot sensibly augment the strain upon a descending cable, nor are they likely to occasion considerable loss.

It has been proposed to increase the floating power of deep-sea cables, by attaching floats at intervals; but it appears to me that such appliances, which depend upon the unerring dexterity of workmen at the moment of danger, and which moreover do not relieve the cable from retarding strain at the brake, should be discarded, and the cable be made to possess in itself all the requisite degree of buoyancy and strength. For this purpose the conducting wire or wires should be as light as possible consistent with good conducting power, a combination of properties which seems to point to the newly-discovered metal, aluminium, as likely ultimately to supersede copper. The insulated covering of gutta percha increases the bulk without adding to the weight of the cable, being nearly of the same specific gravity as sea water; it improves both the mechanical and electrical properties of the cable, and the only limit to its desirable thickness is its expense. The principal weight, and all the available strength of the cable, reside in its sheathing, which should be made of a material combining strength with lightness, and also with hardness, to resist the crushing and tearing action of the brake-wheel; and there can be no doubt that steel wire combines these qualities in the highest degree, nor do I think it would be much dearer than iron, if power of suspension was taken for the basis of calculation.

It can easily be shown, by the simple rule given above, regarding the strain upon the cable in leaving the vessel (which rule was first suggested by Werner Siemens, in assisting at the laying of the Bona Cagliari cable), that an iron-

* The Author of this Paper is in error with reference to the above statement, if he intends to convey that there was any patent by Messrs. Newall for the form or mode of protecting the insulated core of the Dover and Calais Cable. The great longitudinal strength which the Author states was given to the cable, was due to the combination of ten wires of large dimensions, laid around the prepared core in the ordinary manner of making strands for wire ropes, in which there could be no claims set up for any patent right; and we have never heard that Messrs. Newall ever set up any claim for the exclusive right to protect telegraph wires by surrounding them with a sheathing of iron wire. The idea of so protecting insulated telegraph wires was suggested to Mr. Brett, the originator—the persevering introducer of the submarine telegraph system—as he has admitted and stated during the recent discussion upon the submarine telegraph papers at the Institution of Civil Engineers.

sheathed cable cannot, under the most favourable circumstances, be laid in water of more than 3 miles in depth, without a certainty of rupture taking place; whereas a steel-covered cable might be laid, with reasonable safety, to a depth of 5 or 6 miles, which depth is, I believe, rarely exceeded in any ocean.

Respecting the paying-out machinery, I have to notice Messrs. Newall and Co.'s apparatus, consisting of a solid centre, and hoops for guiding the cable safely out of the hold and the brake, which latter should be made as light as possible, to avoid jerks upon the cable, and should indicate the variable strain put upon it, to harmonise its speed with that of the vessel.

In order to insure continuity of the electric conductor in a cable, a strand of several copper wires is now generally adopted, instead of a single wire, which latter is found to be very liable to break. This simple but useful plan was, I believe, first thought of and acted upon by myself, having ordered some gutta percha coated strand, for experiment, from the Gutta Percha Company, in the spring of 1854, part of which I have laid upon the table.

The electrical condition of the submerged conductor is a subject of the greatest interest, upon which electricians are still divided, and which, treated mathematically, involves problems of the highest order, such as only Professor William Thomson and a few others can hope to deal with effectually. The important point is, however, to arrive, first of all, at a clear understanding of the laws of nature upon which those calculations should be based, and those laws, when rightly interpreted, are always extremely simple.

The submerged (or underground) line wire may be, in the first place, considered in the light of a mere conductor, following Ohm's law, which, as is well known, is to the effect that the amount of electricity passing in a given time depends upon the area of the conductor, upon the electric force (intensity) of the battery, upon the specific conducting power of the material, and inversely upon the length of the conductor. It is expressed by the following formula:—

1. $$P = \frac{E\,a\,c}{l},$$ in which

P, signifies the quantity of electricity passing;
E, the electric force of the battery, or its substitute;
a, the area of the conductor;
c, the specific conducting power; and
l, the length of the conductor.

In the next place, the cable has to be considered in the light of a Leyden jar of extraordinary length, formed of gutta percha, with the conductor for an inner, and the sheathing (or moisture) for an outer metallic lining. This Leyden arrangement has to be charged to a certain degree, before the electric current can make itself felt at the further extremity, but the supply of electricity being limited at every point by the resistance offered by the conductor, according to Ohm's law, it follows that the entire cable can be charged only in a progressive manner, as though it consisted of a series of Leyden jars, charging the one into the other until it reaches the last, which discharges itself through the receiving instrument into the earth. The amount of impediment thus offered to the progress of the electric current depends evidently upon the capacity of the Leyden arrangement, which capacity should be reduced to a minimum for a given size of conductor.

According to Faraday's definition of dio-electrics, the electric charge obeys the same simple law which regulates the dispersion of heat in an imperfect conductor, and which, again, is analogous to Ohm's law regarding electric currents. It follows that the electric charge of a Leyden arrangement is directly proportionate to the lining surfaces—directly to the electric force of the battery (or its substitute) employed, and to the specific inductive capacity of the insulating medium, but inversely proportionate to the thickness of insulating coating; or, if expressed by a formula, we have—

2. $$Q = \frac{E\,S\,k}{d},$$ in which

Q, expresses the electric charge;
E, the electric force of the battery;
S, the metallic surface;
k, the specific inductive capacity; and
d, the thickness of coating.

This formula is corroborated by a series of very careful experiments by Werner Siemens upon electric cables, and it is of great practical utility if combined with Ohm's formula regarding the conductor.

The following are some of the simple consequences derived from the two formulas:—

1. The electric force, E, of the battery (and its substitute) has no influence upon the onward velocity of the electric wave, because it increases the value of P and Q equally.

2. The time $\left(t = \frac{Q}{P}\right)$ required to charge a submerged conductor of a given proportion increases in the square ratio of the length, l, of the conductor—(in the formula, for Q, the factor, S, has to be expressed by l and a)—which law was first arrived at by William Thomson in another way, and was communicated by him to the British Association in 1855, but has since been assailed by Whitehouse and other electricians.

3. It is of the first importance to make the conductor of the best conducting material, and the insulating coating of the greatest practical thickness, but of a material with the least specific conductive capacity.

4. Given the materials and the thickness of the insulating coating, the rapidity of progress of the electric wave increases in the simple ratio of the diameter of the conductor; a proposition differing also from the views of the promoters of the Atlantic cable, who assert that the maximum result is obtained by a conductor of comparatively small diameter.

The results obtained by means of these formulas are, however, modified by disturbing causes, which have to be taken into account by the electrical engineer. Among these the conducting power of the gutta percha itself is the most important. It appears, from certain data of experiments made at Gateshead, by Messrs. Newall and Co., upon one-half of the Atlantic cable, that when the entire cable is formed into an electric circuit, only about one-third part of the current will follow the wire throughout its length, and the remaining two-thirds will pass through the gutta percha covering to the earth. The relative amount of leakage through the covering increases in an extraordinarily rapid ratio with an increase of temperature; and it must be deemed a most fortunate circumstance that the temperature of the great oceans is probably not above 40 Fahr. at the bottom, being the temperature of maximum density of water. Messrs. Buff and Beete have found that glass also becomes conductive of electricity when but moderately heated; and they attribute the effect to electrolysis, or decomposition of the alkali it contains. In the case of gutta percha, it arises possibly from decomposition of the water of hydration, or of some vegetable constituent of that substance. A careful experimental inquiry into this question, including some other deteriorating effects upon gutta percha, would be of great practical importance; and it is to be hoped that the Gutta Percha Committee, lately appointed by this Society, will furnish some valuable information.

The effect of leakage through the coating is retardation, in the direct proportion of the surface of the conductor, and the inverse ratio of the thickness of the coating; but the coefficient varies according to the temperature and quality of the material. There are some other disturbing causes, of comparatively less importance, namely, volta-induction and magnetisation of the iron sheathing by the line-wire current. The volta-induction, or tendency of one current to produce a current in the opposite direction in another conductor parallel to itself, is of importance only in the case of compound cables, and may even be turned to advantage, if the return current is laid through one of the parallel wires instead of the earth. By the same expedient, magnetisation of the sheathing, which is necessarily a retarding cause, and is, moreover, productive of a disturbing extra current, may be neutralised.

In calculating the time required for an electric current to traverse a cable of given length and proportion, it may be received as an experimental datum to start from, that it reached the distance of 1,000 miles in one second, in a cable consisting of No. 16 Copper wire, coated with gutta percha to the thickness of 5-16ths of its diameter, a proportion most generally adopted. The discharge of the same cable would occupy practically about two seconds, and these times go on increasing in the ratio of the square of the length of conductor, in as far as the retardation by electric charge is concerned, and in the simple proportion of losses by leakage, volta-induction, and magnetisation, the result being a mean between the two ratios.

With these facts before us, it would have been impossible to work an electric telegraph across the Atlantic or Indian Oceans with anything approaching a commercial result; and the idea must have been abandoned, but for Faraday's timely discovery that several electric waves may co-exist, following each other, in a long cable, whereby the number of impulses to be transmitted in a given time may be greatly increased.

A difficulty experienced in carrying this method of working into effect, is the partial emerging of the separate waves into an almost uniform electric charge of the conductor, which causes the receiving instrument to be permanently affected. This difficulty has, however, been removed by a return to Gauss and Weber's method of working, in sending always two opposite currents in succession, whereby not only the effective value of each wave is doubled, but accumulation of electric charge is entirely prevented, because the two opposite waves, in emerging, destroy each other. This method of working would, however, not be complete without a return also to the same description of current which Gauss and Weber employed. It has, indeed, been shown above, that currents of high electric force do not travel any faster through submerged conductors than feeble currents, but the advantages of the former are—that each electric wave represents a larger accumulation of force, and travels consequently to a greater distance before it has so far dispersed as to be no longer capable of producing an effect upon the receiving instrument, and, moreover, that the positive and negative impulses are equal in amount.

The success of a long submarine line of electric telegraph depends also in a great measure upon the particular construction of both the communicating and receiving instruments. On this point I am in a position to speak from extensive experience, being connected with an establishment which had to contend at an early period with the difficulties experienced upon long underground lines, which has since carried out extensive systems of telegraphs in Russia and other countries, and has furnished the instruments of most of the continental lines, including those in Turkey, India, and Australia. In addition to this there is the experience of the Black Sea and the Mediterranean lines, which are the longest submarine lines hitherto constructed, with the instrumentation of which I was charged by Messrs. Newall and Co., the successful contractors of those undertakings.

Morse's recording instrument combines, as stated before, many practical advantages which recommend it for universal adoption for all mercantile lines, among which advantages is the facility it offers of forwarding messages at intermediate stations without the intervention of a clerk, in putting on a fresh battery, a system first introduced by Siemens and Halske, and perfected by Steinheil, by which it is made possible to speak directly between London and the remote parts of Russia.

The real telegraphic receiving instrument is the relay, which has for its duty to establish and break the local circuit of the recording instrument.

An important point in the construction of a delicate relay was the suppression of the armature of the electro-magnet employed (patented by Werner Siemens in 1851), by allowing one of the two upright bars of soft iron composing the horse-shoe electro-magnet to vibrate upon delicate points, and producing rotary motion by the attraction between approximated horizontal arms extending from

the same. The application of magneto-electric currents necessitated a corresponding change in this relay; for, however sensitive it might be made, it was necessary that the effect of the line-wire current should be continued till the recording instrument has had time to make a dot or line upon the paper, and the magneto-electric current, being nearly instantaneous, is unsuited for that purpose. This difficulty has been removed by the introduction of permanent magnets, which continue the effect produced by the instantaneous action of the line-wire current until the opposite effect is produced by the succeeding negative current. The vibrating tongue of the instrument is for this purpose balanced midway between the poles of a comparatively powerful permanent magnet, being equally attracted by both, but remaining in the proximity of either of them, into the attractive sphere of which it happens to be brought by the instantaneous action of the line-wire current, changing for an instant of time the name of one of the contending poles. A relay on this principle was first exhibited at the Great Exhibition of 1851 by Siemens and Halske.

The relative dimensions of the inductive coils, and of the coils in the relay (depending upon the length and other conditions of the cable itself), are points which require very careful attention. The common practical rule, that the resistance of the coils must be increased with the increased length of conductor is here entirely at fault, for the electric wave, when once formed, is no longer under the influence of its source, but may be compared to the dying wave of the ocean running up a shallow beach, which would have no power to force its way through a long and narrow tube, but is yet capable of delivering a large quantity of water into an open duct. For an analogous reason the coils of the relay must be composed of comparatively short and thick wire. The same rule applies to the inductive coils, which must be composed of thick wire, in order to produce a quantitative wave. The Cagliari, Malta, and Corfu line is worked by instruments upon this principle, and the results obtained are very satisfactory—the messages being worked through the entire distance of 700 nautical miles (without making Malta a relay station) with ease, and at a sufficient rate.

This result proves that telegraphic cables not exceeding a thousand miles in length may be worked satisfactorily, and that, consequently, all reasonable doubts about the successful operation of a line from London to Calcutta may be considered as being removed, a result which I sincerely hope to see soon established in fact.

For distances exceeding a thousand miles, the difficulty of sending messages at an efficient rate for commercial purposes remains yet to be solved, for theory and experience combine to prove that the highest rate likely to be attained in working through a distance equal to the intended Atlantic cable, in taking full advantage of the power of waves, will not exceed four, or it may be five, words per minute—unless, indeed, some new principle of working is yet discovered, whereby a greater result is realised.

There would be one way, indeed, in which the capabilities, not only of long submarine cables, but of electric telegraphs generally, might be greatly increased, which consists in combining a number of insulated line wires into one cable, and working them in metallic couples. This, indeed, is giving up the earth current, but, in its stead, we gain the power of working several sets of instruments without disturbing interference between the wires by voltaic induction. Instead of using one of the wires (say the central wire) for the common return circuit, the metallic pairs might be selected by the rule of permutations, which, if carried out, would enable us to connect six pairs of instruments by means of four wires, ten pairs by means of five wires, and so on. If a cable of ten wires was laid between two great commercial centres (say between London and Liverpool), as many as 42 pairs of instruments might be used, which might be placed in the counting-houses of great merchants and of their respective agents, for their private correspondence; and this step would probably give rise to the more general application of the electric telegraph for private and domestic communication. The instrument that appears to be best suited for such purposes (including railway and town services) is a magneto-electric step by step or dial instrument, a specimen of which I have placed before the meeting. This instrument combines the advantages of requiring no battery, with great facility of working, and it contains some novel arrangements, whereby its action is rendered powerful and certain, and which will be best understood from the drawing.

Of these instruments, 180 were adopted last year by the Bavarian Government, in lieu of instruments of a similar class that had been used there previously, and it appears, from an official document, that they give great satisfaction. A pair of them is also in use at the War Office and the Horse Guards; and another pair was used by Messrs. Newall and Co., to keep up telegraphic communication between the tender and tug employed in laying the last Mediterranean cables.

My summary of telegraphic novelties would not be complete without a notice of a method of sending messages simultaneously in both directions through one and the same line-wire, the joint invention of the Hanoverian telegraph engineer, Frischen, and my brother. It consists in splitting the current of the battery into two equal parts, of which the one proceeds through the line, and the other through an adjustible resistance coil by a short circuit to the earth. Both currents pass in opposite directions round the relay magnet of the communicating station, and neutralise each other in effect, but the portion of current passing along the line wire produces an effect upon the relay at the receiving station, and *vice versa*; but if both stations include their batteries at the same time the current of the line wire will be doubled, and in exercising a preponderating effect upon both relay magnets will cause both to attract their respective armatures, and establish the printing circuits. By this means the transmitting power of a single line wire is doubled. This system works satisfactorily between Amsterdam and Rotterdam, and some other places where there is not much interference by intermediate service, but it is, I consider, as yet too refined for general application. The same objection applies to a system of accelerating the speed of transmission of messages by preparing strips of perforated paper which, in passing between a metallic roller and contact finger, break and restore the metallic current with unlimited rapidity—a system first introduced by Bain, years ago. These plans will very probably be of great practical utility eventually, when the use of the electric telegraph is more extended.

In conclusion, I have to thank the meeting for their patience in listening to this Paper, which far exceeds the limits I had assigned to it. I have to express my special thanks to Professor Wheatstone, Mr. Latimer Clark, Dr. Green, Mr. Edward Bright, and Messrs. Newall and Co., for their liberal aid in furnishing me with models to illustrate the subject.

I wish to draw particular attention to the key and relay arrangements of Mr. C. Varley, which are used upon the Dutch cable, and the Acoustic telegraph, worked by secondary circuit, which is used by the British Magnetic Telegraph Company, and which lack of space has prevented me from describing in the Paper. The Paper is, I am aware, deficient in many respects, but I shall be satisfied if I have succeeded in showing, by what been done, what greater results may yet with certainty be accomplished; and if, by inviting discussion, I have contributed to hasten the period when the electric telegraph will no longer be the wonder of the age, but will become the simple and ever ready agent to extend the range of human intelligence and power upon the earth, fettered no longer by the limits imposed by distance.

INSTITUTION OF CIVIL ENGINEERS.

March 2, 9, 16, and 23, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

Four evenings were entirely devoted to the discussion of the Papers On Submerging Telegraphic Cables, by Mr. J. A. Longridge, M. Inst. C.E., and Mr. C. H. Brooks, and On Paying-out and Repairing Telegraph Cables, by Mr. F. C. Webb, Assoc. Inst. C.E.

The discussion was commenced by remarks upon some of the deductions in the two papers, which, it was argued, could not be accepted implicitly. It was contended, that there was not any proof of the cable arranging itself in folds or coils at the bottom of the sea, and that the "waste," or surplus length of cable laid down, could not be as much as 30 to 50 per cent. more than the actual distance traversed. There was not sufficient foundation for these statements, and therefore they were considered to be erroneous. By a model exhibited it was shown, that a small chain, when uncoiled from a roller round which it was wound, was delivered in a straight line as the roller travelled along upon the upper plane of the model. Hence it was argued that, allowing for the greater buoyancy, or the reduction of specific gravity, by immersion in water, a cable could be laid at the bottom of the sea, in the track of the ship, exactly as it left the coil in the hold, without any loss of strength. The concavity of the line of cable from the ship, as exhibited in the diagrams, was contended to be imaginary, and the wavy folds, also depicted, were doubted.

Arguing from the uncoiling of a chain in air, and making allowance for the resistance offered by the deposit of the cable in water, the following table was given of the various degrees of tension in delivering from a ship, assuming the minimum tension to be when the cable hung vertically, it being then the weight, in water, of a piece of cable whose length was equal to the depth of the sea:—

The Angle made by the Cable at the ship, with the horizontal line, being:—		The Tension of the Cable at the ship, expressed in terms of the minimum tension, would be:—
5°	....	262·8
10°	....	65·8
15°	....	29·4
20°	....	16·6
25°	....	10·7
30°	....	7·47
35°	....	5·53
40°	....	4·27
45°	....	3·41
50°	....	2·80
55°	....	2·35
60°	....	2·00

Thus, when a cable was payed out at an angle of 10° (which was reported to have been the case in the Hague telegraph), there was a strain upon it of nearly sixty-six times the minimum tension, or sixty-six times the depth of the sea at that place. This, in shallow waters, was unimportant; but in the Atlantic, where the depth was 2,000 fathoms, it became a matter for serious consideration. This table was not given as an accurate representation of what occurred in water, but it was a close approximation.

The mode of construction of the cable was also objected to, inasmuch as it was contended that the external iron wire covering being laid spirally would yield when the strain came upon it; whilst the gutta percha core, containing the conducting wire, being straight, would be liable to fracture. Thus the insulating medium being cracked, the cable would become useless. This was merely thrown out to elicit from practical men information as to whether any means had been devised, in manufacturing cables, to throw the tension upon the external wire covering.

It was explained that the conclusions given in the first paper were based upon the mathematical reasoning given in the appendix. The methods proposed for catching the end of the cable, in case of fracture, were only intended as suggestions, and were not insisted upon; but where so much capital was at stake, and when a single accident might risk the whole venture, any means of catching the end of the cable deserved attention.

As to the processes of paying out and of repairing cables the former was comparatively simple and easy, whilst the latter involved a series of different opera-

tions constantly changing in character. It was impossible to treat both questions fully, and, therefore, the greater prominence was given to the former, as being more generally interesting.

It was explained that it would be desirable to have the external wires of a cable laid straight, if it were practicable; but it was not so, and, therefore, arrangements were made for giving to the internal conducting wire, with its gutta percha covering, a spiral form, which conferred on it a greater degree of elasticity than was possessed by the outer wires, which would, therefore, be ruptured before the inside wire was injured. When the Dover and Calais cable was torn asunder by a ship's anchor in January, 1857, it was found that the inside wires were much longer than those of the external covering, and that the gutta percha was uninjured, except at the point of rupture.

It was also stated that in every instance in which the Atlantic cable had been tested for strength, the iron outer wires were broken before the copper inner wires yielded to an extent to impair materially the efficiency of the conductor.

It was admitted that advantage would result from the use of any appliance by which the egress of the cable could be retarded, so as to allow of heavier and better protected cables being laid in deep water. There were, however, almost insuperable practical difficulties attendant upon the application of any controlling power to a cable of small section, as there were objections to the use of heavy cables of large section in the great depths of the Atlantic. For these reasons resisters, such as buoys, or discs of certain area, had been proposed, and Colonel Beaufoy's experiments showed that a retarding strain could be put upon the cable when sinking, but if it became requisite to draw the cable up again, the extra strain would act very prejudicially. There were, however, mechanical means of detaching these resisting floats when a contrary strain occurred. It was not considered to be of vital importance, even with a light cable, to compensate for the pitching of the ship, where it was possible to use light machinery for paying out. This should be a primary consideration, as light cables were indispensable for deep water; but up to the present time no light cable had been offered which met all the requirements so well as that made for the Atlantic Telegraph.

The conducting and insulating powers of cables of various forms must be carefully considered, and in those respects, it was contended, that the light cable prominently alluded to in the first paper was very deficient. The researches and lucid explanations of Dr. Faraday, on this part of the subject, were noticed, and it was shown that instead of having a strong conducting iron wire in the centre, it was better to have a smaller wire of copper, the conducting power of that metal, according to Becquerel, being 100, whereas that of iron was only 15, or six times less than copper. At the same time the difficulty of obtaining perfect insulation, and the chances of leakage, were proportionately increased by having a greater extent of surface to protect.

With regard to a remark in Mr. Webb's paper that the Atlantic cable was not tested under water, it was stated that the core was regularly tested from the beginning with a battery series of five hundred cells, and the most sensitive instruments, after having remained under water for some days. The core was then sent to the works upon drums, so protected that it could not possibly be injured, and was immediately covered with a serving of hemp, prior to receiving the outer strands. It was not possible to test the whole cable with the outer strands under water, and it was doubted whether it would have been of any value, had it been practicable. It was true, Professor Morse had correctly stated, that as they got further from the shore in the Atlantic undertaking, the signals were weaker; but a very low battery power was purposely employed, so as to render apparent at once, by the effect on the instruments, any falling off in the continuity, or insulation. As new lengths of cable were added from time to time to the circuit, there was of course some variation of signals, and the adjustment of the instruments was sometimes interfered with by the motion of the ship; but there was nothing uncommon in the occurrence, and the supposition that a fault had passed unnoticed was altogether groundless.

It was urged that the Atlantic cable, in the real sense of the word, had not been tested under water, as the Hague cables were. The gutta percha covered wire was always so tested as a matter of routine; but this core was exposed to many casualties previous to the outer covering being applied.

It was remarked, that although light cables were preferable for great depths, yet in shallow waters heavy cables were necessary, as being less liable to injury; and it was asserted that, in this respect, the light Hague cables would always be a source of considerable annual expense, as compared with the heavy Dover and Calais and Dover and Ostend cables, in which there had only been one instance of failure in five years.

In the first experimental cable from Dover to Calais, consisting of one No. 14 copper wire, insulated with gutta percha, both laid straight, it was found that, when the strain was removed, the gutta percha had a tendency to return to its original length, whilst the wire was drawn down nearly to No. 16 gauge. The wire forced its way through the gutta percha in several places, so that the insulation was destroyed. It was then suggested by Mr. Wollaston that, in a cable containing several wires, the core, including the conducting wire, or wires, and the gutta percha, should be twisted spirally like the outer covering. This plan was now universally adopted.

In reference to the observations which had been made in the early part of the discussion, that cables could be deposited nearly in the same way in water as in air, and that when a cable was paid out at an angle of 10°, the strain would be sixty-six times as great as the weight of a vertical section of the cable hanging from the deck of the ship to the bottom of the sea, where the cable had to be deposited, it was remarked that these observations were opposed both to practice and theory. This reasoning would lead to the inference that, in depositing the Atlantic cable at an angle of 10°, a strain would have been created near the ship equal to about 99 tons, whereas the breaking weight of the cable was known to be only 4 or 5 tons. The argument adduced by Messrs. Longridge and Brooks, that the great strain arose from the tendency of the cable to run down through the water in an oblique direction, though in a straight line, seemed to be correct. This was particularly the case with heavy cables, and could only be resisted by the brakes, and the friction of the water upon the cable. It was urged that floats, or resisters, might be advantageously employed in great depths, and a float was advocated, consisting simply of a flat board, 3 or 4 ft. square, with a long rope attached to the centre by a bridle, like a kite. These floats might be attached by forming an open knot round the running cable; and having lowered the board to the surface of the water, it might be drawn tight, and allowed to run. A float of this kind, 4 ft. square, would, at 5 miles an hour, offer a resistance of about 12 cwt.; and if the velocity was increased to 8 miles an hour, then the resistance would rise to 32 cwt. The fact of soundings having been taken immediately after the failure of the Atlantic cable, in a depth of 2,000 fathoms, seemed to prove the comparative safety with which a light cable might be deposited, or even be hauled up again, although with a heavy cable that operation would be attended with very great risk, even if it were possible. It was confidently asserted that the larger the conductor, the more easily and rapidly the cable would be worked; and it was desirable that the gutta percha covering should be large, so as to lessen the induction. In the case of the Atlantic Telegraph, the first point which had to be ascertained was, the minimum current that would work the instrument at the distant end; and the next object was, to make the conducting wire sufficiently capacious to convey that quantity of electric current to its destination. With regard to that undertaking, the opinion was expressed, that if the brakes were not too heavy, and there was not too much material to be alternately stopped and thrown into accelerated motion by every rise and fall of the vessel, the electric communication might be easily and speedily accomplished.

In reference to the durability of submarine cables it was stated, that the cable belonging to the British Telegraph Company was laid down about four years ago, and had remained perfect ever since. The only cost to the Company for maintenance, or repairs, was a small gratuity to the Coast Guard on each side of the Channel, who were asked to write whenever either end of the cable was exposed on the beach.

It was remarked, that simple cables with a single conductor had cost large sums of money for maintenance and repairs, while under the compound system, with two exceptions, but little or no expense had been incurred. This should be borne in mind in designing submarine cables in future. The plan of paying out a cable from the stern of the vessel was objectionable; for the stern, in rough weather, would evidently rise and fall considerably. The effect of this would be to throw great strain on the cable, unless it was allowed to pay itself out to such an extent as to prevent any alteration in the catenarian curve, and thus waste a large portion of the cable, a loss being sustained on the passage of every wave. The preferable part of the vessel for the cable to leave the ship seemed to be the centre, or the centre of gravity, by which all waste from the pitching or rolling of the vessel would be avoided. A conical hole, with the apex of the cone tending upwards, should be made for the purpose, and then the cable would not be chafed by rubbing on its departure on any part of the vessel. The almost certainty of a storm occurring during the operation of laying down the Atlantic cable rendered it the more desirable that every precaution should be taken which could be devised to insure success. And if it were not possible to alter a vessel so as to pay out at the centre, then a ship should be specially built for the purpose.

The small number of words at present capable of being sent through the Atlantic cable—the number being, according to the Company's Report, only four per minute—had induced Mr. E. Highton to devise a code system for use in long lengths of telegraphs. He exhibited an instrument which was capable of transmitting through a wire eight hundred million times two million preconcerted messages, the maximum period for the occupation of the wire not exceeding ten or twelve seconds, if sent at the rate at which the Queen's Speech was transmitted from London. He also explained one of three instruments used in the transmission of the American President's last Message, which consisted of upwards of sixteen thousand words, at the rate of three thousand five hundred words an hour. The desirableness of magnifying the effects of electricity arriving at a distant station, especially in the case of leaky wires, had led to the invention of an instrument for the purpose.

It had been found that the light and heat of the sun, the mycellium of a fungus, and other substances and conditions, had the power of rendering gutta percha unfit for the insulation required for the transmission of messages by means of electricity. Several specimens of gutta percha in a decayed state were exhibited, and also a piece of copper wire, 5 ft. in length, covered with gutta percha, which was strained until it broke, when the gutta percha, owing to its partial elasticity, contracted, and left 7 inches of copper wire uncovered. A newly-made tube of gutta percha, under a strain of 276 lbs., stretched from 14 in. to 24 in. before breaking; but a similar tube which had been exposed for about five years to the atmosphere, light, and heat of the sun, was so brittle as to be easily broken by the hand.

It was further contended that when a spiral wire enveloped a soft core, the integrity or electrical condition of the inner core was liable to be injured and be destroyed, in consequence of the straining and stretching due, partly, to the weight of the protecting covering itself.

With regard to the failures of several light cables, including the first from Dover to Calais, the first from Holyhead to Dublin, and one from Portpatrick to Donaghadee, it was shown that there was not the slightest identity in the principles of their construction, and that they were early experiments in submarine telegraphy. And as 50 per cent. of all the submarine cables hitherto attempted to be laid had been failures, no argument against light cables, as opposed to heavy cables, could be based on such premises.

It was urged that these facts showed that the mechanical construction of the rope was at variance with maintaining intact its electrical conditions as a conductor. Hence, it had been proposed to make a cable light in weight and light in specific gravity, and having the greatest strength in the centre. The weight being only half a ton, or less, per mile, a length of 2,000 or 3,000 miles might be conveyed in one vessel: and the specific gravity being low, all brakes, the

source probably of four-fifths of the failures hitherto met with, might be dispensed with, when paying out. Such a cable could, from its lightness, be easily handled—be run out free over a pulley, like a hempen rope—be laid out horizontally on the water—and be paid out at a rate of eight or ten miles per hour, instead of four or five miles per hour. Thus, a straighter course could be maintained, there would be less waste, and, as the whole operation could be completed in about half the time usually occupied, there would be less liability of accident from foul weather coming on. The form of rope here alluded to was said not to be liable to stretch, so that the electrical integrity of the conductor would be preserved during the process of submerging; and the conductor itself being larger must, it was believed, be more efficient for longer distances. The philosophy of the argument used in reference to the Atlantic cable, that the greater the distance to be traversed the smaller should be the conductor, was not one that could be credited.

It was agreed that it was desirable that cables should be as light as possible compatible with their sinking; but, at the same time, they must have strength as well as lightness, and it was as to where that strength should be placed that there was a difference of opinion. If the strength was entirely in the centre, surrounded merely by insulating materials, it was feared, that when exposed to high temperatures, and when coiled in large masses in the hold of a ship, the conducting core might force its way through the yielding gutta percha, and so destroy the telegraphic communication. This effect would also take place when any strain was put upon the cable by the necessary machinery to give sufficient retarding force.

It was regretted that so little attention appeared to be given to the paying-out machinery, which, it was contended, should be designed with a view to keep a retarding force upon the cable equal to the difference in speed between the vessel and the cable. But as the speed of the former varied, owing to the wind, currents, and other causes, the measure of this difference in the paying-out machinery should be by means of a spring, or a pulley, carrying compensating weights, which, by its rise and fall, would indicate the increased or lessened speed at which the vessel was going, and to regulate the strain upon the cable, so as to make it as uniform as possible.

It was stated that, in paying out the Mediterranean cable from Cagliari to Bona, Mr. Werner Siemens had employed an apparatus which not only regulated the strain upon the cable, by the deflection of a weighted lever resting upon the cable, between the break and the stern pulley, but also overcame, to a great extent, the evil effects of the pitching of the vessel. When the vessel pitched, the weight rose and allowed more cable to run out, so that the pulleys of the break travelled at a uniform velocity.

With reference to the best form for a submarine cable, it had been proved that, when great depths had to be traversed, one of light specific gravity was to be preferred. The conductor, which constituted the weight to be carried, should, therefore, be as light as possible; and to insure its continuity, it should be relieved from strain by the external coating. The conductor, when of copper, had a specific gravity of 11, the gutta percha insulator was nearly equal in weight to sea-water, and the iron external covering had a specific gravity of 7. Probably, aluminium might be substituted for copper in deep-sea cables with advantage, as it was nearly equal in conducting power, and was only one-third of the weight. If an iron conductor should ever be carried out, it would be found that the retardation by lateral induction, which was the great impediment against the successful working of long submarine communications, would be much increased, and eventually would become practically insurmountable. The thickness of the insulator ought, in all cases, to be increased with the length of the cable, in order to diminish the retardation by lateral induction. The outer covering should be of hard material, so as to resist the longitudinal strain during the process of submerging, but it should add as little as possible to the weight. It was considered that no material fulfilled these conditions so well as soft steel. A thin steel wire coating would produce a cable of the least weight, and be capable of suspension to the greatest depth. Nor should it be more expensive than iron, if the power of suspension was taken as the basis of the calculation.

It was stated that, before the present Atlantic cable was decided upon, from twenty to thirty specimens of different forms of light cables had been tested for strength, by means of a hydraulic machine. The form adopted was the strongest with one exception. A cable with a steel wire coating was found to be superior in that respect; but in addition to its great cost, it was ascertained, that it would have been impossible to obtain the necessary quantity of wire in less than from one to two years. In these tests it was proved that, in the specimens covered with a spiral lay of iron wires, when subjected to the breaking strain, the core, the conductor, and the gutta percha, were found to be perfect; whilst in those covered with hemp, or hemp and steel wire, the gutta percha was so cut and injured as nearly to destroy the insulation. In the Atlantic cable, the repeated coverings of gutta percha, in place of a single coating, and the adoption of seven twisted copper wires for the conductor, were important improvements; for it was improbable that flaws should occur in each of the seven wires at the same place. It was mentioned that, when paying out this cable last year, the *Niagara* on two occasions hove to, in depths of 1,900 to 2,000 fathoms, until the cable hung vertically over the stern, without the least injury resulting.

With regard to the failures in the attempts to lay a heavy cable between Sardinia and Africa, in the years 1855 and 1856, it was stated, that it was due, in both instances, to want of length. Proof had, however, been obtained, that it was possible to submerge a heavy cable, successfully, in a depth of 1,640 fathoms. It was all-important, in enterprises of this kind, to ascertain, with accuracy, the relative speed of the ship, and of the paying out of the cable. In the cases last alluded to, the log was hove every quarter of an hour, and the length of cable payed out was ascertained from the number of revolutions of the drum. By these means the brakesmen regulated the tension. It was believed that the greatest speed practicable, in ordinary cases, would he found to be from five to six knots per hour. Floats, or resisters, had not been used in these instances, where a depth, as previously stated, of 1,640 fathoms had been successfully attained; but it was thought that it would be prudent, in an operation like the laying of the Atlantic cable, where a distance of upwards of 1,600 miles had to be traversed, to employ a good system of buoys at every 300 or 400 miles.

With respect to the durability of electric cables after submersion, it was remarked that pieces of iron fished up from the bottom of the sea were found to be coated with a solid mass of concrete; so that it was fair to presume that the Atlantic cable, when once submerged in the still depths of the ocean, would, before it was destroyed, form for itself a protecting covering. And though gutta percha when exposed to the atmosphere, or laid underground, might be subject to decay, yet, when submerged in the ocean, it was found to be perfectly preserved, as was proved in the case of the Dover and Calais cable.

It was believed to be capable of proof, that if a chain lay upon any inclined surface, whether straight or curved, it would be exactly balanced by the weight of another portion of the same chain equal in length to the vertical height of the inclined plane; and this would be the case, whether both portions were in air, water, or other fluid. A cable continuously delivered into the water at a certain angle need only, therefore, be restrained by a force equal to the weight in water of a portion of the cable whose length was equal to the depth of the water. If the bottom of the sea was horizontal, then the "waste" would be equal to the difference in length of the hypothenuse and the base; or, in practice, a quantity not more than would be required to cover the irregularities of the bottom. The greatest strain would be independent of the velocity of the ship, and would depend solely on the depth of the sea. If the strain was less, then the cable would slip down the supposed inclined plane, and occasion greater waste. If greater, then a portion of the cable at the bottom would approach to a catenarian arc; and if the tension was needlessly increased, the whole cable would assume a catenarian form; but no known materials would be sufficiently strong to bear such a strain. The necessity for, or fear of, enormous catenarian strains was, therefore, groundless. It would be possible, by means of a sufficient number of floats, or resisters, to lay a cable, however deficient in strength, in any depth of water.

The vertical velocity of the Atlantic cable would be about 3 ft. per second; and assuming it to weigh in water 15 cwt. per mile, and to break with a strain of $4\frac{1}{4}$ tons, then there ought only to be a strain of $1\frac{1}{2}$ ton when paying out in a depth of 2 miles. Nor should it be exposed to any much greater strain, provided the brake apparatus was properly contrived and efficiently worked. When the vessel was progressing at the rate of 6 miles per hour, the "waste" should not be more that $5\frac{1}{2}$ per cent. Steel wire was certainly better adapted for deep-sea operations than iron wire, inasmuch as the modulus of tension for steel was 6,700 fathoms, whilst for iron wire it was only 4,000 fathoms, and for bar iron only 3,000 fathoms.

In illustration of the advantages of paying out the cable from the centre of oscillation of a vessel, in place of from the stern, it was asserted that the stern of the *Niagara*, in passing over the crest of a wave 20 ft. in height, and from 600 to 700 ft. in length, would rise or vibrate 75 ft., causing violent and sudden tension of the cable, whilst the centre would only rise 20 ft.

To this it was replied, that the rise and fall of the stern, above or below the horizontal line of such vessels as the *Persia* or the *Niagara*, in crossing the Atlantic, never reached 10 ft.

The principal difficulty to be apprehended in laying down a telegraph cable in deep water was thought to arise from the probable existence of deep-sea currents. If it was certain that these did not exist, then a cable of a little greater density than water might be adopted. On the other hand, if such currents had to be passed, the cable should be as small as possible, of great strength, and of high specific gravity, so that only a short length should be exposed to the force of such currents. The present knowledge did not seem to be sufficient to enable anyone to say whether deep-sea currents might be disregarded, so as to justify the use of cables covered with longitudinal fibres of hemp (which, weight for weight, was double the strength of iron) served with hard yarn, well soaked in pitch and tar.

It was believed that the failure in the attempt to lay the Atlantic cable last year arose from the cumbersome nature of the paying-out machinery. So long as the weather continued fine, the operation was carried on successfully; but when a breeze sprung up, the rigidity of the brake apparatus was such as to prevent the necessary allowance for the rise and fall of the stern due to the undulations of the sea. It was, therefore, proposed that the brake should only exert a uniform constant retarding force, and that the additional strain due to these causes should be compensated by suspending the delivery pulley by vulcanised india-rubber springs, in such a way that there should be always 50 ft. or 60 ft. of cable in reserve, without resorting to the brake.

As a practical illustration of the facility with which light cables could be laid, it was mentioned that although the submarine telegraph between Varna and the Crimea was submerged under considerable difficulties, and during a storm, yet the actual length payed-out was only $3\frac{3}{4}$ miles in excess of the distance between those places, which was nearly 350 miles. The depth of the Black Sea where this cable was laid was about 70 fathoms. The cable consisted, throughout the greater portion of its length, simply of a No. 16 copper wire, served with gutta percha, and wholly unprotected. The shore-ends had an iron sheathing, extending to a distance of 10 miles from Varna, and of 6 miles from the Crimea. Its insulation was perfect, and it remained uninjured for twelve months, during the time of the Russian war, notwithstanding the many violent storms to which it was exposed in the Black Sea, until, during a storm of more than usual severity, it was broken on the 5th December, 1855. From various trials which had been made it was believed that the fracture had occurred very near to Varna. Portions of a similar cable, which had been submerged for some time in the Black Sea, had been recovered, and in these the gutta percha was quite sound, and covered with a thin white deposit.

With regard to the assertion, that a large wire conducted more slowly than a small one, it was argued that, although when the area of the wire was

increased the inductive surface was also increased, yet the ratios between the two were not the same. For, if the diameter of the wire was doubled, the area would be increased four times, and the resistance would consequently be reduced to one-fourth; yet the surface, and consequently the inductive action, would only be doubled. It was believed, that by doubling the diameter of any wire, and coating it to the same depth with gutta percha, signals would be obtained in half the time.

It was remarked, that the great experiment of the Atlantic Telegraph had the best wishes of all engineers; but it was felt that sufficient attention had not been paid, either to the mechanical appliances, or to the construction of the cable itself, which the vast importance of the undertaking demanded. The cable had not been submerged in its entirety, and tested in that state, to ascertain its condition. Nor had any effort been made to determine what would be the effect upon the gutta percha core of a pressure of three or four tons to the inch, at a depth of 2,000 fathoms. The failure was stated to have occurred when the cable was momentarily left in the charge of a workman; but it was much to be deplored that so great an enterprise remained, even for an instant, in the care of unscientific hands. Nor did it appear to have been necessary, for an experienced member of the scientific staff was at the time on board the *Agamemnon*, where his services could not possibly then have been required.

The Institution was under great obligations to the Authors of the first Paper under discussion, who were the first to treat this subject in a logical manner, and to bring to bear upon it mathematical and mechanical knowledge. At the same time, there were so many novel elements involved in its consideration, that it was hardly possible to do more than attempt to approximate to general principles, without finding the exact amount of strain that the cable would be subjected to.

In the commencement of the discussion it had been said that it was impossible there could be any "waste," and this position had been illustrated by a model, in which a chain was suspended and payed out from a cylinder, showing exact agreement between the length payed out and the distance traversed. Had, however, the chain been coiled upon a larger or smaller part of this cylinder, either the operation would have been brought to a standstill, or more cable would have been payed out than was due to the distance traversed by the cylinder. It had also been said, that whether the cable was payed out in air or in water, the circumstances would not be modified to any material extent. Now, a bar of iron, 1 in. in diameter, and 2 miles in length, would weigh 13 tons, and if this was suspended vertically in the water the resistance, at $5\frac{1}{2}$ miles per hour, would amount to 50 tons. When the vessel got into motion, the bar would immediately assume an inclined position, and adjust itself to the horizontal, then the strain would be reduced. The Atlantic cable being about straiu, and probably, in the case cited, the inclination would be 4 to 1. If, however, the specific gravity was reduced, and the inclination was nearer to the 5-8ths of an inch in diameter, the resistance at the depth stated would be about 30 tons; and as the breaking weight was about 4 tons, it was clear that that cable should be inclined so as to reduce the strain to 2 tons. Therefore, as 2 tons was to 30 tons, so was the square of the sine of the angle to the radius; from which it resulted, that the least length at which the cable should be payed out was from 8 to 9 miles from the vessel to where it touched the bottom of the ocean. Whenever the speed of the vessel was reduced, the cable would have a tendency to assume a vertical position, and this would bring into play the direct weight of the cable, more or less, in addition to the above resistance, so that the strain would be increased. The result of these considerations led to the belief, that a much lighter cable than that proposed would be found most advantageous for long distances at great depths.

It was remarked that if a submarine cable was allowed to pass freely over a pulley into still water, gravity being the only force tending to sink it, the strain would be its own weight less the buoyancy due to the column of water. This quantity would not be affected by the speed of the pulley; but the friction would differ with varying velocities, as would also the strains caused by the passage of knots or splices. During the change from one velocity to another, due to entering cross or side currents, extra strain would be encountered. It was believed that experiment alone could determine the value of these several strains; but it was thought to be dangerous to make the specific gravity of deep-sea cables more than twice that of water. It was suggested that the paying-out apparatus should consist of an air cylinder, with a light piston, so connected with the brake as to free it instantaneously if necessary; and that the brake should be automatic in its action, and so regulated as to prevent any accelerating velocity in the rope.

With regard to the objections which had been made to the form and specific gravity of the Atlantic cable, it was remarked that it had been laid over the most difficult portion of the route between Ireland and America, and that the accident of last year was in no way attributable to its form or structure. The present cable was a practical invention—the result of reasoning and experiment—and was entitled to confidence until a cable was devised which could be shown, either by actual results, or by the united testimony of competent authorities, to be more suitable for submersion in deep water. In confirmation of this opinion a Report was read, which was signed by all the engineers engaged in the undertaking last year, from which it appeared that those four gentlemen concurred in the belief that the cable was eminently suited for laying in deep water, and they did not recommend any change being made in the manufacture of any future cable for crossing the Atlantic. The opinions thus expressed were in perfect accordance with those of the commanding officers attached to the telegraphic squadron, from whom a communication had likewise been addressed to the Board of Directors.

It was urged that Messrs. R. S. Newall and Co., the contractors, who undertook the entire risk of laying the cable for the Mediterranean Telegraph Extension Company, had, in all but the external wires, adopted precisely the same form as that of the Atlantic cable, the only difference being that the external covering was of eighteen solid wires, instead of eighteen strands of wire. The effect of using these solid wires was merely to diminish the flexibility of the cable without adding to its strength, whilst its specific gravity considerably exceeded that of the Atlantic cable. Yet, notwithstanding all the theoretical arguments in favour of a lighter structure, that cable had been successfully submerged in depths of 1,900 fathoms—was now in regular work—and had thus completed an important link of telegraphic communication.

From an authentic record of the height and velocity of the waves off Cape Horn, where they were believed to be greater than in any other part of the world, it seemed that the utmost oscillation ever noticed did not exceed 32 ft. in height, or 16 ft. above and 16 ft. below the horizontal line.

It was stated that the whole of the inner portion or core of the Atlantic cable was carefully tested under water, and was again subjected to a severe test, while out of water, at the manufacturers. It was further tested a third time when completed, and for the fourth time when on board ship. It was considered that it would have been impossible to test the whole cable under water, in any practically useful manner; and it was believed that there was not a single instance in which a cable of any important length to be laid in deep water had been so tested.

In reply to the observations of preceding speakers, it was stated that the results arrived at and contained in the first Paper submitted to the Institution were not mere opinions, but were deductions from strict mathematical reasoning, the whole of which was given in the Appendix. The different problems which presented themselves for consideration, and their modes of solution, were then generally explained. Some misapprehension seemed to exist with reference to the subject of resisters or floats. If of less specific gravity than the cable, their effect was to decrease the tension, by imparting buoyancy to the cable. The other effect, as resisters, would be very small, unless the cable was running out with great waste. They ought not to be attached in a parachute form, but should be fixed on to the cable itself, and, probably, a spherical form would be most convenient. In the case of a comparatively heavy cable, like the Atlantic cable, it was very desirable to ascertain, experimentally, how far the danger arising from its weight could be remedied by such means. Attention was then drawn to the curious result arrived at with respect to currents, and it was observed that the waste of cable due to their action was very small, and that they caused no extra tension. The inutility of seeking a reduction of tension by letting the cable run out with slack was pointed out, and illustrated by diagrams.

The effect of the pitching of the vessel was adverted to, and it was shown that very heavy and dangerous strains might be brought upon the Atlantic cable from this cause; and that such strains could scarcely be avoided when using the ponderous paying-out apparatus presumed to be required for so heavy a cable. The gearing together of the sheaves was considered to be dangerous; and self-acting brakes, however perfect, were decidedly inferior to the manipulation of vigilant and intelligent men in an operation of this nature, where the conditions were constantly varying.

The paying-out apparatus proposed in the course of the discussion, for regulating the strain on the cable due to the varying velocities of the vessel and the cable, by means of compensating weights, was stated to have been carefully considered, and made the subject of mathematical investigation. The result showed that, theoretically, the disadvantages were greater than the advantages, and that it also involved considerable practical difficulty.

With respect to stretching the cable, it was maintained that although such stretching might not actually fracture the gutta percha, yet it might so attenuate it as to increase its permeability to water, under the pressure due to great depths. Experiments had been made which showed that gutta percha was, to some extent, permeable by water at a pressure of 2 tons per square inch; and it was, therefore, urged that further investigation should be made into so important a matter.

Objections had been taken to light cables, because the first Dover and Calais cable, and some other light cables, had failed. In reply, it was stated that every cable must be designed to suit the particular circumstances of the case and the locality where it was to be used. In shallow and disturbed waters, cables strongly protected must be employed; but in deep water, where no violent action existed, no such protection was required, the great object being to get the cable safely to the bottom. It was shown that this was fully admitted by the promoters of the Atlantic cable, who had publicly stated that the iron sheathing of the cable was only intended "to serve the end of protecting the coated core from mechanical violence, and to confer upon the cable a convenient amount of proportionate weight during the process of submergence," and that, "when the cable is once fairly laid in the still soft depths of the Atlantic, the rust may eat up the iron coat as soon as it pleases." It had been proved, practically, that the amount of "proportionate weight conferred upon the cable by this outer sheathing" had been anything but convenient, and it was evident that so far the avowed intentions of the designers of the Atlantic cable had not been fulfilled by the practical result. It was an undeniable fact, that a light cable could be laid with much greater safety; and it was, therefore, to be regretted that the engiueers of the Atlantic Telegraph Company still, in spite of the falsification of their anticipations, by the result of last year's experience, adhered to the opinion that no improvement could be made in the construction of the cable.

With reference to the remarks which had been made upon one particular form of light cable, it was contended that the objections raised as to the size and materials of the inner core were of no importance whatever. An invariable diameter of the inner core was not insisted upon, any more than the use of iron to the exclusion of copper. All that was advocated was, that the whole of the metallic portions of the cable should be placed in the inside, instead of partly within and partly without. The diameter of the core, its material, the thickness of gutta percha, &c., were all varying elements, which should, in each particular cable, be proportioned to the work to be done. No dogmatic rule was laid down on these points, but a principle of construction was advocated entirely different from the iron-cased cables generally in use.

With regard to the comparative difficulty of paying out and repairing cables,

it was contended, that the former was the more simple and straightforward operation. The repairing of a broken cable 60 miles from land, by underrunning, picking-up, grappling, buoying, splicing, &c., all of which processes had to be performed on the open sea, and out of sight and shelter of land, and where the distance of the fault from the shore could only be ascertained approximately by electrical tests, would not be regarded by engineers as so perfectly easy as had been assumed.

The statistics of the submarine cables hitherto essayed, showed that out of forty-three attempted to be laid, six only had failed during the process of laying, four subsequently, and one of the Hague cables was at present under repair, leaving thirty-two in perfect working order. These facts completely disposed of the assertion, that 50 per cent. had either failed in being submerged, or immediately afterwards. Of the ten total failures, three were strictly light cables, with no outer wires, being the only uncovered cables tried: and the two failures of heavy cables after submersion arose from their being too light. Several cables had, it was true, been broken by anchors, in consequence of the absence of sufficient iron-protecting wires, but these had been immediately repaired, and were now in regular work. Of the six failures in submerging, two occurred with the Mediterranean cables, in the years 1855 and 1856, when 256 miles were lost, of the value of about £70,000; a third with the Newfoundland cable; a fourth with a light cable from Port Patrick to Donaghadee; a fifth with a heavy cable on the same route; and lastly, the Atlantic cable. Of these, the Newfoundland and the heavy Port Patrick and Donaghadee cables had been recovered, and during the present summer the raising of the Mediterranean cable was to be attempted.

In reference to the mechanical and electrical questions involved in the consideration of this subject, it was regretted that the paper by Messrs. Longridge and Brooks had not been discussed in proportion to its merits. If mathematical investigation could ever be relied on in practice, confirmed as it was, in this case, by geometrical analysis and by actual experience, that Paper ought to be of great use in guiding those who had the superintendence of the paying-out of cables in deep water. It had been shown, that to lay a cable straight, a strain must be exerted equal to what had been termed the minimum tension, or the weight of a piece of cable equal in length to the depth of the sea where the cable was being payed out. That result was contrary to what had been generally supposed to obtain, but there was no practical proof that it was incorrect. According to this law, the required tension for the Atlantic cable, for a depth of 2,000 fathoms, would be 34 cwt.; but this strain had never been continuously applied to the brakes for any length of time, so that this experiment did not disprove the rule. The tabulated results, showing that as this limit of tension was decreased, the loss or "waste" was considerably increased with a slow speed of the vessel, and *vice versâ*; that a very little easing of the strain was obtained by allowing great loss; and that as the velocity of the ship was increased, the tension might be much decreased with a moderate loss, had been more or less suspected in practice, but the facts had never been previously worked out and recorded with such clearness and precision. Finally, that Paper showed that a decrease in the specific gravity of the cable was the real remedy for great tension. No doubt, if a cable could be decreased in specific gravity, without diminishing its strength, or in a greater proportion than its strength was decreased, all other necessary conditions being complied with, the difference between the breaking strain, and the strain required to support a given length of the rope in water, would be augmented. This had been aimed at in the Atlantic cable, by reducing the weight of the outer covering of iron wires, and proportionately enlarging the gutta percha; and the opinion was expressed that no plan had hitherto been proposed by which this difference could be materially extended, that did not possess other serious disadvantages. No system had yet been devised superior to a metallic sheathing for affording lateral protection during the act of submerging in all cases, and giving permanent strength in shallow seas.

If the layer of wires were smaller, they would be more unstable, and afford less lateral protection, by which the perfection of the insulation would be exposed to great risk. By the use of steel, however, the absolute strength of the cable might be augmented, without any increase in its specific gravity. It was considered that a plan which had been suggested, for placing the iron wires around the conductor, and within the gutta percha, would increase the risks in a mechanical point of view, setting aside its electrical disadvantages; for, in summer temperature, the required strain for paying out a cable of this kind of the specific gravity of 1.5, would force the metallic core through the gutta percha, and even the weight of the cable in the hold of a ship would have a tendency to flatten the rope. A better system would be, to have a simple copper conducting wire, surrounded with gutta percha, and covered with hemp. With regard to the objections to the spiral "lay" of the wire, it was explained, that before any elongation could take place, the spiral must be straightened. This could only arise, taking a single wire, in two ways; either by the spiral being flattened, or by unwinding. The first of these effects could only occur by the wires crushing one another laterally, or by a wire being forced inwards, but this was prevented by the solid core, which acted as a kind of centering, and kept the whole in stable equilibrium, whilst the tension on the wires did not admit of their being forced outwards. The second effect could only happen when one end was free to revolve whilst the rope was under tension; for if both ends were held tight, it was evident that one part could not be unwound without winding up the other. A well-made solid wire telegraph cable would not stretch more than three-quarters per cent., and this would not injure the gutta percha core in the slightest degree. A cable with a strand of wires would be more liable to elongate.

The system of paying out cables from the centre of oscillation had been frequently suggested, and although it presented another advantage not previously mentioned in the discussion—that of facilitating the steering, it had not been deemed expedient to adopt it. The cable would form a sharper angle round the bottom of the vessel than it would over the stern, so that the crush on the cable, tending to flatten it, and the friction, would be increased; and should there be a broken wire, which with the greatest care would sometimes occur, there would be no means of freeing it, as when paying out over the stern. But perhaps the most serious disadvantage was, that there would be no means of ascertaining what the sailors term the "grow" of the cable, or the horizontal and vertical directions it assumed after leaving the ship; by which, in the one case, valuable information was obtained as to whether the vessel, or the cable, was being acted upon by currents, or by tides; and in the other, a rough and ready means of approximating to the strain on the cable. The cutting for buoying, and the change from one hold to another, and so altering the "lead" on to the brake, would also be attended with certain practical inconvenience.

In reference to the statement, that the best angle at which to pay out a cable was about 45°, it was remarked, that this would necessitate the speed of the vessel being limited to half a mile per hour; and in answer to another statement, that the loss, or "waste," could not possibly exceed 1 per cent., instead of from 30 to 50 per cent., or be arranged in wavy folds at the bottom of the sea, as described in the second Paper under discussion, it was observed that, in the case of the Atlantic cable, 350 miles were payed out, although the distance traversed was only 250 miles; and if this supposition was not correct, it was difficult to imagine how the extra length was disposed of.

In paying out the Atlantic cable, the reception of an electric current seemed to have been used as a test for insulation. This, it was contended, was a dangerous principle. For as long as no resistance was added to the circuit, a partial fault might pass, without producing any other inconvenience than an additional adjustment of the relay, which might be set down as the effect of the ship's movement. But when resistance was added, after a fault had passed, a much greater decrease in the strength of the received current, than that due to the resistance of the additional wire, if there were no fault, would occur. It had not been stated whether the cable was tested for insulation, with strong battery power, the last thing before it parted, with a perfectly favourable result; and this alone could give positive evidence of the perfection of the insulation.

In conclusion, the hope was expressed that the Atlantic undertaking might be carried to a successful issue during the present year; for it was to be feared that another failure would destroy public confidence in such enterprises, and so retard the much-desired extension of telegraphic communications.

REVIEWS AND NOTICES OF BOOKS.

New Process for Laying the Submarine Telegraph Cable. Proposed by Thomas Landi and Charles Falconieri. Paris, 1858.

THIS is a pamphlet of eight pages, acccompanied by a plate, illustrating the means Messrs. Landi and Falconieri propose to employ in submerging and grappling telegraph cables. The operations connected with submarine telegraph cable paying out and recovering, seem to have been pretty well considered by the authors; and their suggestions as to float-boards and parachutes, as a means of retarding the too rapid descent of telegraph cables, accord with opinions expressed by some of the practical telegraphists during the recent discussion at the Institution of Civil Engineers; and there are several ingeniously-contrived instruments for facilitating the attachment of these floats and parachutes to the cable.

On the Submergence of the Atlantic Telegraph Cable. By Captain M. S. Nolloth, R.N.

THIS is the substance of a lecture delivered at the United Service Institution by Captain Nolloth. It describes the effects observed with the rapidly-increasing depth of the ocean, whilst paying out the Atlantic Telegraph Cable during the attempt made last year. It gives many interesting details, which have already been published, but which serve, nevertheless, more usefully in their present form for the purpose of reference. The subject has been so recently brought before the Institution of Civil Engineers, and so fully reported in THE ARTIZAN, that it is unnecessary to enter into a discussion on Captain Nolloth's views. One suggestion, however, which we find made by Captain Nolloth, page 10, is to attach a supplementary cable of coir rope, by means of lashings, to the telegraph cable. Now, apart from the questionable advantage of such a plan, we need scarcely point out the greatly-increased space which will be required for stowage, the liability to foul whilst being payed out, and other practical difficulties and disadvantages, which no doubt are thought very lightly of by those who have no practical experience of the difficulties attendant on paying out submarine telegraph cables at sea.

The Carpenter's and Joiner's Assistant, &c. Blackie and Son, London. Parts 5 to 12.

WE have received the several parts which have been published since our Number for January. The high character of the work is fully maintained in the Numbers now before us, and there is no doubt of its becoming, when completed, a perfect encyclopædia of carpentry and joinery; and, being published at so moderate a price, is within the means of every practiser of those arts.

CORRESPONDENCE.

MASS AND WEIGHT—VIS VIVA.

To the Editor of The Artizan.

SIR,—The tone of Mr. Löwenthal's last communication entitles him to a courteous response. I hope by planing a little off the edge on my side, and the same on his, that a close joint may be made between us. If I had known that the paradoxes of his former Paper were to be attributed to his imperfect acquaintance with the English language, I should have refrained from holding them up to ridicule.

I quoted a definition of the term MASS, the purport of which is, that the whole quantity of matter in a body is its mass, the proper measure of which is

its *weight.* Mr. Löwenthal objects to this; the weight may be varied by changing the distance of the mass from the earth's centre of gravity, while its quantity of atoms remains constant. Warr, in his "Dynamics," coincides with this objection.

The absoluteness and universality of the definition are thus justly impeached. But when Mr. Löwenthal considers that we have not to experiment with the mass at the equator, and weigh it at the pole, but do both at the same parallel of latitude, I think he will find his objection to become evanescent. At any place the weight of a mass is its proper measure, for dynamical purposes, at that place, and it cannot be in two places at once. I will not comment upon what appears to me to be the mysticism of some of his remarks. Nor will I dispute his proposition that, "if mass and weight be identical, then bodies which have no weight could have no mass." Who can safely affirm that there is matter without weight? The surface of the earth is but the bottom of an ocean of atmosphere, in which we live and move about. The bubble that rises to the surface of the water at our feet is full of matter that has weight! And the gas in the larger bubble of the aëronaut, which rises above our heads, has its weight also. Surely, in a dynamic inquiry, constantly appealing to the function of gravity, we may be excused for neglecting imaginary imponderable substances. I assure Mr. Löwenthal, "You all are wrong and I alone am right," is not my sentiment. My object in embarking in this discussion was to aid in producing a formula of a simple approximate character, so that if certain data derived from the ship, and the indicated H.P. of the engines be given, we might be able to determine nearly what speed ought to result. The absurd formulæ $\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} = C$ and $\frac{V^3 \text{ Mid. Sec.}}{I.H.P.} = C$, were my first obstacles. They no longer in their entirety stand very formidably in the way. The V^3 makes an obstinate stand, but I feel certain that it is not invincible. I aim at being right, but have erred too often to deem myself infallible. I do not "think all others are wrong." I find my fundamental conceptions supported by Newton, Robison, Atwood, and philosophical writers generally. Dr. Arnott expressly states that power varies as the square of velocity; and I find in "Chambers' Natural Philosophy," Hydraulics, page 33, "In steam navigation, if an engine of 50 H.P. impel a vessel at seven miles per hour, it would require two of the same power to drive her ten miles per hour." This is their theoretical view. By personal experience and practical observations, extending over a great range of instances, I *know* variation in indicated H.P. is not so great as V^3 would give. The engineer has an immense amount of power to bestow upon the inertia of his machinery, and a yielding fulcrum; and the action of his propelling instruments do not give their reaction in the direct line of motion: but this forms no part of our inquiry at present.

Kepler is said to have looked nature "full in the face," that he might "extract her secrets from her." We all know that his planetary discoveries were made in this way. And it is my opinion that we must close our books for a short time and examine the phenomena of fluid resistance for ourselves, if we wish to arrive at a sound conclusion. I admit that engineers are generally against me, although I am acquainted with several distinguished exceptions. Their theory is pressure × space.

I have submitted a great many arguments against this theory as frequently applied in the course of this controversy; I will briefly state another:—

Disregarding all considerations of the incipient motion, while (to use Mr. Moseley's words) "the aggregate work of the forces which tend to accelerate exceed that of those which tend to retard," and considering the velocity as equable, and the pressure constant; assuming also that the elements of resistance connected with a ship's immersed body may be deemed equal to the resistance of a plane of the requisite magnitude; it then appears to me to have the truth and obviousness of an axiom—that, if the pressure be the same upon two planes of different areas, the larger will do the same work as the smaller in a less space in the same time, because it would be impossible for it to be moved through the same space in the same time without doing more. This is utterly ignored by the pressure × space theory. And with two planes of the same area, if different pressures behind them produce different velocities, it is because it is an imperative law of nature that the work done in front *in the same time* shall be equilibrated with the pressures. *It is impossible that any increase of motion can result if resistance, considered as a pressure, is increased in the same ratio as the urging pressure.*

Weight, motion, and *time,* are the elements of "WORK." A plane driven through water 10 ft. overcomes the *inertia* of 10 ft. of water. Here *inertia* is the substitute for *weight.* The motion is 10 ft. *Time,* as a measure, must be unity. I tabulate these data for conciseness.

Area of plane. Feet.	Time. Seconds.	Motion. Feet.	Inertia.	Work.
1	1	10	10	$10 \times 10 = 100$
1	1	20	20	$20 \times 20 = 400$

which is as the *square* of velocity. If two masses of matter, having weight relatively 1 : 4, be raised vertically by two pressures, which are also as 1 : 4, *they would be raised with the same velocity.* If the same pressures raised them with velocities in the ratio 2 : 1, their relative *resistance* to motion from gravitation cannot be 1 : 4, but must be 1 : 2; and fluid resistance, measured by the action of gravity on falling bodies, must be likewise so considered. I cannot perceive how this can be denied; but, if it is true, the cube theory is manifestly false. Perhaps Mr. Löwenthal will ponder over these suggestions. If they are true, admit them; if they are untrue, expose their falsehood; and if they are absurd, laugh at them.

There is one more topic—it is *vis viva.* And here I must entreat Mr. Löwenthal not to suppose that I underrate the stupendous mathematical skill of such writers as Moseley, for instance, or that I doubt the correctness of their calculus or their conclusions: I profoundly admire the former, and implicitly rely upon the latter. A body in motion is conceived to have force in it—it imparts that force in a definite time, and, *continuously,* in proportion to its velocity: and if the whole of the force could be taken out of it in *no time,* then the whole would be found to be in proportion to the square of the last velocity. But this is impossible. A bullet projected into butter will ultimately lose its force, and if projected into hard wood the same result will follow. Now, if another bullet be projected into both of these substances, with double the velocity of the former, it will be found that it will penetrate four times as far; but in both instances it will be twice as long in doing so. The density of the substance penetrated may be increased *ad infinitum;* but when penetration becomes mere percussion, time is infinitesimally small, and the fourfold effect appears to be produced in an instant. Now, all the observed phenomena of nature are consonant with this conception; and this is the basis of *vis viva,* as far as rectilinear motion is concerned. And we have nothing to do just now with central forces and angular motion. It would be easy to follow mathematicians in their course. Gravity, and the law of falling bodies, are brought in to measure this force; formulæ are excogitated, in which g, the symbol of gravity, is prominent; and we find $\left(\frac{w}{g}\right) v^2$, called *vis viva,* and $\frac{1}{2} \left(\frac{w}{g}\right) v^2 =$ accumulated work. This is utterly unobjectionable. The objection is to giving the principle a generalisation beyond its legitimate limits. I do not find it applied in the works of the eminent men referred to, to such a case as we have in hand. But I must quit this subject: Mr. Mansel demands my attention.

Really, this spurious *vis viva, quasi* force, or *living* force, which is *not* force, will be the death of us! What a controversy this is! If Mr. Mansel persists in his quibbling diatribes, Greek comedy will be outdone by Scotch farce, and Glasgow will become as celebrated for its verbal *bulls* as Kilkenny is for its contentious cats. The Carisbrooke *vis viva,* it would seem, has been endued with the faculty of speech, and become "*sententious!*" I should have thought that the poor beast would have been quite garrulous, as the consequence of such a miracle! My opponent, it is but justice to say, is extremely amusing. Albeit, he is apt to mistake clumsily-expressed spleen for wit—a stereotyped formula for mathematical analysis—dogmatic assertions for argument—and an unfounded imputation of forgery as a master stroke of scientific polemics,—the last mistake he reiterates, after having taken six weeks to "digest the venom of his spleen." There is a turpitude in this which the ludicrous character of his other *escapades* hardly atones for. I perceive you have quoted from Earnshaw, at the instance of a correspondent, the very passage he impugns. The words are: "The principle of *vis viva* is not true if any of the bodies move in a resisting medium;" and the reasons, which are irresistible, are assigned in the context. The solecism, "mass of a particle," does not appear in my Earnshaw. The fact is, I suppose, we have consulted different editions, and have placed ourselves in the position of the two travellers who quarrelled about the colour of the chameleon, and probably have been both laughed at by your readers for doing so. I still imagine (joking apart) that heat would be *liberated* if produced by the Falls of Niagara, and that the transition state of a body between rest and equable velocity is of a uniform character. Certainly not the technical uniformly accelerated velocity produced by gravity simply, but uniform in the sense my words implied.

Amplification upon these extraneous matters would, however, merely waste your space and my time. Mr. Mansel says, "But what the Master of Trinity declares to be luminous, 'G. J. Y.' confidently asserts to be a 'fool's light.'" Mr. Mansel knows that I never used the expression—he does not *say* that I used it; but he wishes your readers to suppose that I have done so. The cunning of this artifice is on a par with its malevolence.

Concurring with Smeaton, I said that the height to which a given weight is *raised* in a unit of time is the measure of power. I am now asked if I admit the proviso that "this is to be understood only of slow or equable motion, &c." Undoubtedly! The weight must be *raised,* not *projected.* But why ask this? Does Mr. Mansel mean to throw *his* "foot-pounds" overboard that he may save *his* "*vis viva*"? 'Twere a vain sacrifice! Project two equal bodies vertically upwards with velocities 1 : 2. The heights they would reach would be 1 : 4; but the time of ascending would be 1 : 2. The forces lost *in toto* would be 1 : 4; *in the same time,* 1 : 2, *i.e., as velocities, and not as velocities squared.* Atwood wrote after Smeaton, and corrected some of that great man's mistakes. If Mr. Mansel will consult "Atwood on Rectilinear Motion," he will find demonstrated, from experiments with the celebrated machine, illustrated with profound mathematical skill, that if the force of gravity be brought to bear upon the inertia of a mass of matter by the instrumentality of any assigned falling weight, *then the* INERTIA *overcome is precisely in the inverse ratio of the velocity, and not of the square of the velocity.*

Mr. Mansel incurs no danger of a combat by throwing down the following gauntlet:—He says, he "defies me to produce either fact or tenable argument in opposition to the principle, that forces produce their full effects in the direction of their action, whatever be the velocity of the body on which they act." We shake hands here.

But then there is an under-current of error passing through his mind, while he enunciates this mechanical truth. It is this:—If a pressure of any given amount be employed at the stern of a steamer to drive her through the water, that then, as the pressure "*produces its full effect,*" the measure of the power expended must be expressed by multiplying the numerical value of this pressure by the numerical value of the space through which the steamer moves—whereas the same pressure may drive one vessel eight miles in an hour that drives another two, and the expenditure of coals be nearly alike in both cases: to put 8 P = the expended power in one case, and 2 P = its expenditure in the other, would be enormously absurd; but this absurdity is the basis of the cube theory, and quite in accordance with some of the arguments put forward by Mr. Mansel.

I stated "that a 20 lb. weight falling with a constant velocity, drawing a floating body through the water at 10 ft. per second, must have the resistance

of that body reduced to draw it at 20 ft. per second; and a weight of 80 lbs. falling at 20 ft. per second, will draw a body through the water which has four times the resistance of the latter, but not of the former." Over this, to make it "*definite,*" he throws an algebraic mist, first assuming "that the work done by gravity on the constant falling weight is equal to the work expended on the resistance." In one sense this must be conceded, because there is no increase of force by acceleration in the falling weight; but in any other it is merely begging the whole question at issue. I contend that the weight falls faster or slower in inverse proportion to the energy of the retarding force through every portion of the path of the floating body, and that, consequently, with the same falling weight, a "foot-pound" of the retardation at 10 ft. velocity is not a unit of the same value as a "foot-pound" of retardation at 20 ft. velocity. If it is, why does the pound pass through the foot twice as fast in the one case as in the other?

Let us now dispel the mist referred to.

He represents the velocities in the first proposition by V and v, and by C and c he denotes "two terms involving the mid area of the floating body." I understand him to mean that C and c represent all the elements of resistance concentrated in the floating body before and after it is reduced. If so, he will allow me to simplify the conception, by saying, C and c denote two planes. He then proceeds—

$$\text{If } 20 \times V = C\,(10)^2 \times 10,$$
$$\text{And } 20 \times V = c\,(20)^2 \times 20,$$
$$\text{Then, obviously, } C = 8\,c.$$

No doubt of it! As indisputable as the equation that $2 + 2 = 4$.

Have I misapprehended Mr. Mansel's meaning? The terms of the proposition are—A 20-lb. falling weight is to draw c through the water twice as fast as it draws C. Will it do so if $C = 8\,c$? Let us examine. If 20 lbs. equal resistance, and resistance is velocity^2 × area,

Then $V^2 c = 20$, and $v^2 C = 20$;

Therefore, $V^2 c = v^2 C$; and, if $C = 8\,c$: as assumed.

Then $v^2 8 = V^2$.

But $v = 10$; therefore $10^2 \times 8 = V_2$, and $V = 28{\cdot}29$.

So that Mr. Mansel's notions, and his algebra together, would give the small plane too great a velocity by 8·28 ft. per second.

Let us try again. If Mr. Mansel can manage to put his preconceptions in abeyance for a moment, it will be clear to him that, as $V^2 c = v^2 C$, it follows that $V^2 : v^2 :: C : c$; or, numerically, $20^2 : 10^2 :: C : c$, or $C = 4\,c$.

If he doubts this, let him try two planes, one having four times the area of the other, and two others with areas as 8 to 1; and if he does not find the former meet the requirements of the proposition better than the latter, I will confess myself vanquished.

There is one more mistake. He designates M. Comte a *metaphysician*, postponing his strictures upon my quotation from the "Positive Philosophy" for an "obvious reason." I do not perceive how the reason for his forbearance is obvious by anything he has vouchsafed to say; it may, however, be guessed, when we consider that M. Comte *utterly eschewed metaphysics*, and that his work is *anti-metaphysical* from beginning to end.

And now I take a "long farewell" of Mr. Mansel; yet I must add a sentence or two more at parting. He assumes an air of dignified remonstrance with regard to my epithets. He politely commenced by charging me with "pretentious ignorance," and has kindly capped his climax of civility with an imputation of fraud. Surely, if Scotch gentlemen think proper to employ in discussion the prickles of their thistle, they ought not to complain if we adopt their national motto, *Nemo me impune lacessit*.

G. J. Y.

THE CONSERVATION OF THE MECHANICAL EFFECT OF FORCE.

To the Editor of The Artizan.

Sir,—Mr. Mansel's reading of the fundamental principles of mechanics appears to coincide so exactly with my own, that I flatter myself if he will use the same courtesy in discussion with me as with Dr. Eckhardt, the correspondence that occupies such a prominent place in your columns may be brought, in a short time, to a satisfactory conclusion.

The subject of the discussion may be thus briefly stated:—Does a given force, passing through a double space in a unit of time (one second), produce a twofold mechanical effect (raising or impelling foot-lbs.)? the "cube theorists" asserting that it does, while the science of mechanics asserts that a twofold force is indispensable to produce a double mechanical effect in the same time, or one-half the force a double amount of time.—*Vide* Smeaton, "Philosophical Transactions," 1776, page 448.

These assertions are the application of the principle quoted by Mr. Mansel, "that forces produce their full effects in the direction of their action, whatever be the *velocity of the body* on which they act;" or, as it was denominated by Leibnitz, Bernoulli, and every philosopher of the last century, the *conservatio virium vivarum*, or, in plain English, the conservation of the mechanical effect of force, which implies that this effect is a constant quantity, and cannot be increased or diminished by the application of *increased velocity*, the lever, pulley, inclined plane, the wave, or any other form of water-line in naval architecture.

This principle is in strict accordance with the laws of motion, but, from the ambiguous mechanical terms used in them, are scarcely ever applied to any problem connected with mechanics; for this reason I will attempt to place before you more expressive terms, and the three laws in language as to be more readily understood or applied.

1st. Statical pressure (S P) is the weight of matter, or a pressure of steam *at rest;* that is, the pressure of steam on the ends of the cylinder.

2nd. Dynamical pressure (D P), the force exerted by matter, or a pressure *in motion;* that is, the pressure on the piston of the engine in *uniform motion.*

3rd. Retarding pressure (R P), the weight raised, or resisting force; and

The unit of space, an English foot, although not absolutely correct, is sufficiently near for practical purposes; and the unit of time adopted, one second; therefore, with these terms, the three laws may be thus expressed:—

1st. Every force remains in a state of rest when the statical and retarding pressures are equal, and only in motion when these pressures are unequal.

2nd. The mechanical effect of force is a constant quantity; that is, there is a unit of space (to be determined), in which force acts to produce its maximum of mechanical effect (foot lbs.)

3rd. Action and reaction are equal; that is, the sum of the retarding and dynamical pressures are equal. On these axioms, the following formulæ of uniform motion are easily deducible:—

$$\text{Uniform Velocity} = \frac{S\,P}{R\,P}$$

$$\left.\begin{matrix}\text{Dynamical Pressure and} \\ \text{Retarding Pressure ..}\end{matrix}\right\} = \frac{S\,P}{\text{Velocity.}}$$

See Atwood, page 36.

Statical Pressure = R P × Velocity.

Motion becomes uniform when D P = R P.

In opposition to these axioms, the "cube thorists" equate the retarding pressure to the statical pressure, and assert that they are always equal at every velocity. As an illustration, let it be conceded that the square of the velocity, in feet per second, is the amount of force required for a plane one foot square; it is sufficiently near to the actual as to render it more convenient in practice than the formula of Colonel Beaufoy.

Therefore, as an illustration, the cube theory will stand thus: a 64lb. force will propel a plane 64 ft. square 1 ft. per second; 4 ft. square 4 foot per second; and 1 ft. square 8 ft. per second. Consequently, according to that theory, the number of foot-pounds in these examples will be respectively 64, 256, and 512; which is certainly not consistent with the principle "that forces produce," &c., for it will be found that the latter example has produced eight times the mechanical effect, although the area of the plane is $\frac{1}{64}$ of the first assumption. These figures may be accepted as facts; therefore the assumption of the retarding pressures increasing as the square of the velocity *is false*, for by the principle "that forces produce," &c., the retarding pressure merely increases as the speed; consequently the number of foot-lbs. of retarding pressure in the three examples would be equal, and consistent with the conservation of the mechanical effect of force.

By this mode of reasoning, I am now able to define the amount of the "absolutely definite and indestructible nature of mechanical effect." It is neither more nor less *than one pound retarding pressure through one foot in one second, by the action of a force of one pound*, viz.:—

Force.		Retarding Weight.		Feet per second.
1 lb.	will raise	1 oz.	with a velocity of	16
1 „	„	2	„	8
1 „	„	4	„	4
1 „	„	8	„	2
1 „	„	16	„	1
1 „	„	32	„	·50
1 „	„	64	„	·25

The product of the two last columns is an illustration of Smeaton's measure of the power raising it, which Mr. Mansel has quoted several times, and accepted as correct, but certainly is not consistent with the cube theory, any melthe product of the *force and space passed* over as the measure of the mechanical effect. It is Mr. Mansel accepting Smeaton's measure of power that induces me to think that he will be the first to see the fallacy of the cube theory.

In this communication, one example out of the many attempts that have been made to increase the mechanical effects of force by lengthening the bows of a vessel, shall now be produced. It has often been brought forward as a proof of the fallacy of the theory advanced by me in your columns. I allude to the *Flying Fish*, the data being as follows:—

Velocity Knots.	I.H.P.	Mid. Sec.	Velocity of piston. Feet per second.
11·60	1,106	270	5·59
11·20	877	270	5·12
9·92	576	270	4·42
After lengthening the bow 30 ft.:—			
12·57	1,309	270	5·77
11·15	918	270	5·10
10·12	660	270	4·50

In the application of the principle of the conservation of the mechanical effect of force, the formula

$$\text{Vel}^2 \text{ feet per second} = \frac{\text{Force} \times 1 \text{ unit}}{\text{Mid. Sec.}}$$

becomes the proof, whether the vessel has performed on her trial trip all that Nature's laws admit of; therefore, if the speed of the vessel is not equal to the deduced speed, the engines or propeller does not possess the power of transmitting the force in the cylinders to the vessel; for, on no consideration, can the bows of the vessel be admitted worse than a plane, the application of the theory being as follows:—

Actual velocity. Feet per second.	A V^2 lbs.	Actual force. lbs.	Deduced speed.	Ratio of speeds.	Ratio of forces.
19·60	103,680	108,884	20·07	·97	·94
18·92	96,660	94,239	18·65	1·01	1·02
16·76	75,870	67,826	15·84	1·05	1·10
After lengthening the bow:—					
21·24	121,770	124,666	21·49	·98	·96
18·84	95,856	99,077	19·15	·98	·96
17·10	79,110	80,666	17·29	·99	·98

Comment is superfluous; the increased speed, after lengthening, is entirely due to the increased pressure in the cylinders of the engines, and not to the increased lengthening of the bow of the vessel, which has been so often asserted as the cause of the increased velocity of the vessel at "*full power.*" It only remains for me to point out that the second and third columns is the explanation of the third law of motion. Deducing the speed of the vessel *by one unit of space*, the proof of the second law. The first is manifest. To the "*cube theorist*" the fourth and fifth columns represent the value of the velocity of the piston; and to Mr. Mansel, Mr. Moy, and Dr. Eckhardt's tabular deductions, the value of the coefficients of form and friction, the fourth in velocity, and the ratio of forces in lbs. Therefore, to all parties interested in steam navigation, the square of the velocity in feet per second is the indispensable amount of force required for each square foot of midship section for any rate of velocity, and which has cost this country some millions of money to discover or defeat.

I am, Sir, your obedient servant,

April 14th, 1858. R. Armstrong.

ON CALCULATING THE PROPELLING POWER OF STEAM VESSELS.

To the Editor of The Artizan.

Sir,—I am greatly delighted that an engineer of the distinction of Mr. Atherton gives some attention to my small treatise on "Resistance of Steam Vessels," by which I have essayed to complete, in this peculiar case, the theory hitherto neglected. But the remarks of Mr. Atherton make it necessary to treat likewise "the propelling power," which was not my purpose at first, because these inquiries are not assisted by sufficient experiments, I beg, therefore, that they may be treated with the utmost indulgence.

For the determination of the amount of the necessary "propelling power" of the engines of steam-vessels, which is very different from the mean of the resistance, we will make use of the known principle of mechanics, "that the product of the load $= L$, in the velocity $= v$, must be equal to the product of the moving power $= P$ in the corresponding velocity $= v'$;" or $L\,v = P\,v'$. This velocity, v', of the moving power depends upon the recession of water caused by the paddle-wheels or screw, and can be regarded as a function of the velocity of the whole vessel, or $v' = v\,(1 - n)$, in which the coefficient n must be found by experience. Substituting the value, $v' = v\,(1 - n)$, in the fundamental formula $L\,v = P\,v'$, we obtain $L\,v = P\,v\,(1 - n)$; therefore $P = \dfrac{L\,v}{v\,(1-n)}$, and by division $P = L\left(1 + \dfrac{n}{1-n}\right)$.

In this formula, L is equal to the resistance of the whole vessel, calculated conformably to the rules given in the first chapter of my Paper (Artizan, March, p. 54, Vol. XVI.) For instance, we have found the resistance of the *Leviathan* equal to 552,955 lbs.; if we now adopt the usual H.P. = 550 lbs., raised 1 ft. high in one second,* we find this resistance = 1005 H.P., which is the first part of the required power, and in the *Leviathan* effected by the paddle engine; for, calculating the second part, we suppose previously $n = 0{\cdot}6$, which gives $\dfrac{n}{1-n} = \dfrac{0{\cdot}6}{0{\cdot}4} = 1{\cdot}5$, and the second part $= 1005 \times 1{\cdot}5 = 1507$ H.P; therefore the whole power $= 1005 + 1507 = 2512$ H.P. Mr. Brunel has adopted for the screw-engine 1600 H.P., and for the whole power 2600 H.P., which we also obtain, supposing $n = 0{\cdot}615$. I do not know in what manner Mr. Brunel has calculated his results, but this accordance appears remarkable.

To compare our rules for computing the propelling power with the formula proposed by Mr. Atherton, it would be necessary to give to both a similar form. The analytical expression of our rules is, $\text{H.P.} = \dfrac{(\phi - \phi')\,v^2\,S}{550}\,\dfrac{v}{v'}$, in which $(\phi - \phi')$ represents the numbers given in the Table at page 54 of The Artizan; and v^2 will be found in the Table at page 52 of The Artizan (March, 1858). S is the area of the immersed midship section, and v' the relative velocity of the engine or of the wind. If we employ this formula *f. i.* on a merchant *steamer*, with an angle of 36° on the stern and on the bow, the Table gives for the half angle = 18° : $\phi - \phi' = 0{\cdot}418 - 0{\cdot}162 = 0{\cdot}256$; and the formula would be—

$$\text{H.P.} = \frac{0{\cdot}256\,v^2\,S}{550}\,\frac{v}{v'} = \frac{v^2\,S}{2150}\,\frac{v}{v'} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

The formula proposed by Mr. Atherton is—

$$\text{H.P.} = \frac{v^2\,D^{\frac{2}{3}}}{215}\,v \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The last formula differs principally from the first by the peculiar expression of the area of the immersed midship section $D^{\frac{2}{3}}$, which represents the area of one side of a cube, equal to the displacement D. The second deviation we find in our division 2150, being ten times greater than the division in the second formula. At last, the relative velocity v' (being probably the difference under the velocity of the wheels or screw†, and the velocity of the vessel), is put in the second formula equal to 1; which is not always the case. By these several deviations, Mr. Atherton has found the moving power by formula (2) = 11000 H.P.; whilst our formula (1) gives 2600 H.P., according to the indicated H.P. provided by Mr. Bruuel.

---

* In our first Paper we had put H.P. = 555 lbs., which gives 33,300 lbs., raised 1 ft. in one minute of time.

† If we name v'' the velocity of the paddle-wheel or screw, we find the velocity of the vessel $v = \dfrac{v''}{(2-n)}$.

I have now given, with all deference, my opinion on this important problem, with due regard to a distinguished engineer, and with the frankness commanded by the interest of the science. I wish cordially that the diversity of opinions may soon be decided practically by experiments, directed by an enlightened theory, and that these discussions may give occasion to a more intimate union of the men of science of a favoured island and of an emulating continent.

I am, Sir, yours faithfully,

Dr. Eckhardt.

STEAM SHIP CAPABILITY.

To the Editor of The Artizan.

Sir,—In your April number of The Artizan, page 94, your correspondent, "G. J. Y.," referring to my previous communications, states that "his calculations induce him to guess that the *Leviathan* on her trial trip may be expected to attain the speed of 19 or 20 miles per hour;" but "G. J. Y." does not state whether he means statute miles or nautical miles, nor does he give the assumed conditions of draught, midship section, or displacement, or engine-power, on which he has based his calculations.

Assuming, however, for perspicuity sake, that "G. J. Y." means statute miles, say 19½ statute miles, or 17 knots per hour, the result is 1¼ knots per hour, or 7½ per cent. in excess of the speed (15·76 knots) which, by my table in The Artizan, No. 182, I have put forward as likely to be realised by a packet-steamer of 17,000 tons' displacement, impelled by 12,000 indicated H.P. Under these circumstances of approximate coincidence, I see no occasion for "G. J. Y.'s" denouncing the formula which I have adopted as an "absurdity," especially in comparison with his own process of calculation, as described by himself in the following words: "Really my process, although a laborious one, has been so empirical that it is, after all, but little better than guessing."

I am, Sir, your very obedient servant,

Woolwich Dockyard, April 23, 1858. Chas. Atherton.

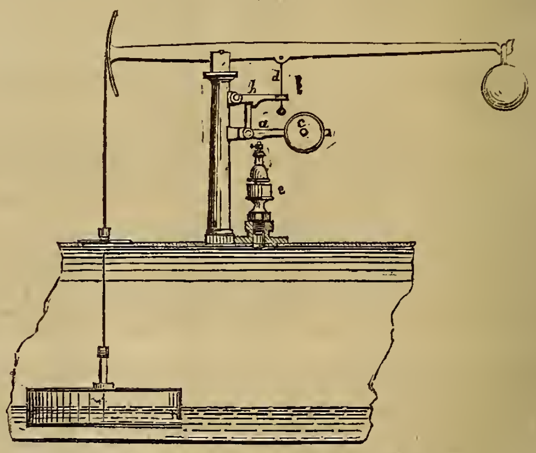
LOW-WATER ALARM WHISTLE FOR STEAM-BOILERS.

To the Editor of The Artizan.

Sir,—Inasmuch as out of ten cases of boiler explosions, nine may be ascribed to shortness of water, every improvement in the expedients for ascertaining the water level in steam-boilers, and for giving warning when the water descends to a dangerous level, may be considered as tending to lessen these frightful accidents. The greater part of the different low-water alarm whistles for steam-boilers are constructed in such a manner that the valve or cock connecting the whistle with the boiler is only gradually opened, so that the warning is not given at any determined point; while in many cases the lever carrying the float is set within the boiler, by which the moveable points of the apparatus soon get corroded, and are very liable to get out of order.

In the apparatus represented in the annexed sketch, both these evils are obviated, all the parts being simple and ready of access, it being no small advantage that it may be connected to almost every common float at a trifling cost. It consists of a common float and lever, the standard of which carries, on two stud-pins, the bell-crank, *a*, and the lever, *c*. This lever is provided on its inner side with a small projection, catching the vertical arm of the bell-crank, which carries a weight, *c*. The end of this lever is provided with an eye, through which passes a small chain, *d*, suspended from the float-lever, and carrying on its under end a small catch. The whistle, *c*, has on its under

Fig 1.



side an opening, which in ordinary cases is closed by an inverted conical valve, which is pressed tight to its seat by the pressure of steam in the boiler. To this valve is connected a small rod, projecting from the upper end of the whistle, where a small ring is fixed on it by means of a set screw, for preventing its falling too low down.

The action of the apparatus is as follows:—When the water in the boiler descends to the determined level, the catch on the under side of the chain raises the lever, *c*, thereby liberating the weighted bell-crank, which, accordingly falling down upon the top of the valve-rod, opens the valve, and the whistle sounds precisely when required; this point being determined by the length of the chain.

Some three or four years ago I devised this contrivance, and all the alarm whistles constructed according to this plan have given the utmost satisfaction.

Deventer, Holland, April, 1858. H. C. Bosscha, C.E.

NEW MODE OF FIXING THE WOOD IN PUMP VALVES.

To the Editor of The Artizan.

Sir,—The grates required for the india-rubber valves in pumps offer a great resistance to the water, which being compelled to force its way through a great number of very small apertures, undergoes a considerable contraction, by which the force required is augmented often considerably. This evil is of no great importance in small pumps, or in pumps having to raise the water to a small height, but is great in the case of large pumps, or where the water has to be raised to a considerable height, so that, in such cases, india-rubber valves cannot be used. For such large valves, a lining of wood, placed endways of the grain, is perhaps to be preferred to any other description of material, as being most durable, and by its elasticity lessening the shock in an

Fig. 2,

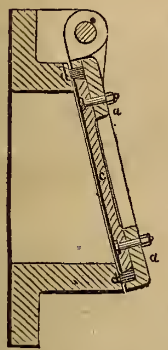
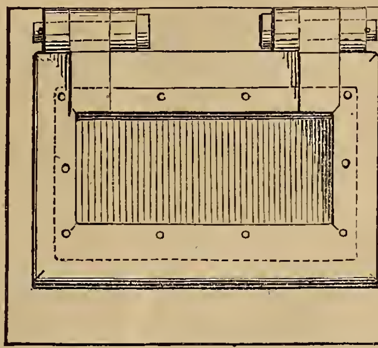


Fig. 1.



eminent degree. A similar lining of india-rubber, by its great elasticity, gives rise to an important loss of water through the suction-valve. The common mode of fitting wood to valves consists in driving it in a groove in the seat, so that it, swelling by the wet, may be firmly held down. By this mode of fixing, however, the wood is liable to get loose; and having had to construct large valves, of which the seats were not easily to be taken out, I decided to fix the wood in the valves, instead of in the seats, so that, when required, the valves may be readily taken out to be relined, or replaced by a new set, when the action of the pump cannot be stopped for a long time.

The valve consists of an oblong frame, *a*, with a projecting rim all round its outside, the inside of the frame and the rim being planed. Inside the rim is set the end wood, *c*, having a wedge-like shape on the inside, and which is held down in its position by a plate, *c*, with a bevelled edge, fitting truly to the inside of the wood, and fixed to the frame by small screw-bolts, *d*. This arrangement permits of firmly fixing the wood, and of readily repairing it, or part of it, when used.

The same mode of fixing the wood may be applied to circular valves, and also, when it is preferred to have the wood fixed in the valve seat, it may be pressed down by a ring, instead of a plate.

Deventer, Holland, April, 1858. H. C. Bosscha, C.E.

LAW CASES.

BETTS v. CLIFFORD.

Mr. Macaulay moved for a rule to show cause why the verdict found for the defendant in this case should not be set aside, and a new trial granted on affidavits. The action was brought to recover damages for the infringement of the plaintiff's patent for the manufacture of what is termed "Betts's metal," extensively used in the manufacture of capsules, &c. The defendant relied on the identity of the plaintiff's specification with that of Dobbs's in 1804. On the previous trial of "Betts *v.* Menzies and another," the defendants were unable to show that anything had been done under Dobbs's patent; but at the trial which took place at Warwick at the last assizes, a witness named Henshaw, who happened "promiscuously" to be in court, tendered himself as a witness for the defendant, and he proved that some years previously he had set up a rolling machine for a gentleman at Birmingham, who had rolled tin and lead under Dobbs's specification. Upon this and other evidence the jury found a verdict for the defendant. The learned counsel now produced numerous affidavits to show that the whole of Henshaw's evidence was an invention, or the result of a delusion, and contradicting his statements in a most circumstantial manner.

The Court granted a rule to show cause.

NOTES AND NOVELTIES.

MISCELLANEOUS.

The Meeting of the British Association.—The local committee for making the preparations for this meeting, to be held in Leeds next autumn, have determined to recommend to the council in London that the Association shall hold its first meeting on Wednesday, the 1st of September. The local committee have now obtained a guarantee fund, amounting to £2,360, and a further sum is expected. The committee have resolved to grant £150 to the committee formed by the Chamber of Commerce for preparing the Exhibition of Local Industry. This object has been taken up by the Chamber, and also by the manufacturers of the town, with great spirit, and a subscription has been set on foot to meet the amount granted by the Association Committee. The place of exhibition will be the large upper room of the Coloured Cloth Hall; but for the heavier machines it is intended to erect a temporary and neat shed, at the upper end of the Cloth Hall-yard.

Decennial Exhibitions of Industry and Art.—The Council of the Society of Arts, bearing in mind the part which the society took in originating the Great Exhibition of 1851, have considered it to be their duty carefully to examine various suggestions for holding an exhibition in 1861, which have been submitted to them, and have resolved:—1. That the institution of decennial exhibitions in London, for the purpose of showing the progress made in industry and art, during each period of ten years, would tend greatly to the "encouragement of arts, manufactures, and commerce." 2. That the first of these exhibitions ought not to be a repetition of the Exhibition of 1851, which must be considered an exceptional event, but should be an exhibition of works selected for excellence, illustrating especially the progress of industry and art, and arranged according to classes and not countries; and that it should comprehend music, and also painting, which was excluded in 1851. 3. That foreigners should be invited to exhibit on the same conditions as British exhibitors. 4. That the Council will proceed to consider how the foregoing resolutions can be best carried into effect. (Signed) P. Le Neve Forster, Secretary.

Institution of Engineers in Scotland.—On Wednesday evening, April 14, this body met for the election of office bearers for the second session, 1858-9, when the following gentlemen were duly elected:—Professor Macquorn Rankine, president; Messrs. W. Neilson, J. R. Napier, and W. Tait, vice-presidents; Messrs. J. Elder, W. S. Dixon, N. Robson, D. Rowan, P. Stirling, A. McOnie, W. Johnston, R. B. Bell, B. Conuor, and A. Allan, councillors; Mr. D. More, treasurer; and Mr. E. Hunt, secretary. A very successful session was wound up by the reading of a paper "On American Locomotive Engines," by Mr. W. Neilson, and of one "On the Stability of Locomotives," by Mr. J. G. Lawrie—animated discussions following both papers.

Opening of the Yan-Yean Waterworks at Melbourne.—The Yan-Yean is an artificial lake, surrounded, or rather crossed, by an embankment of 3,159 ft. in length and 30 ft. in height, connecting two natural elevations of land (ranges), between which formerly flowed the drainage of 5,000 acres. To supersede, however, any chance of a deficiency in the supply of water, an open cut and tunnel, 1,320 ft. in length, connects the reservoir with the River Plenty. The reservoir is nearly 2 miles in diameter and 10 in circumference, with an average depth of 19 ft. The embankment, which measures at the base 170 ft., diminishes with a slope of 3 to 1 against the water, and 2 to 1 on the outside, to 20 ft. on the top, and running the entire length is a solid wall of masonry, 30 ft. wide at the base and 18 ft on the top; this has been carried 10 ft. below the surface, in order to give it ample strength to sustain the pressure of the water; and the whole has been constructed with such solidity as to preclude a possibility of accident arising from any probable sudden accumulation of force.

Copper, Tin, Lead, and Zinc.—Last year 24,143 tons of British copper (ore excluded) were exported from this country, including 7,146 tons of unwrought copper, 154 tons of coin, 13,726 tons of sheets, rails, &c., and 3,103 cwts. of other wrought copper. The countries to which the greatest quantity of copper was exported were the Hanse Towns, Holland, Belgium, France, Italy, Turkey, Egypt, India, and the ports of the United States on the Atlantic. 9,335 tons of British copper were exported from London last year, and 9,129 tons from the sister port of Liverpool. 75,832 tons of copper ore were imported into the United Kingdom last year. The imports of tin in 1857 were 2,708 tons of tin, and 1,387 of tin ore and regulus, and the exports included 2,187 tons of British tin, and 380 of foreign The imports of zinc were 18,001 tons, and the exports 3,123. Of lead the imports were 12,768 tons of pig and sheet lead, and the exports 19,272 tons of pig and rolled lead, 2,816 tons of shot, 662 of litharge, 2,540 of red lead, and 2,875 of white for the carbonate of lead.

The Slate Quarry of Samuel Holland, Esq., at Festiniog, Merionethshire, has just been successfully *lighted with gas* by Mr. George Walcott, engineer.

Victoria Tower.—The contractor for the ironwork is Mr. John Jay.

Messrs. Tuxford and Sons, of Boston and Skirbeck Iron Works, have shipped another of their traction engines to Cuba, making the third within the last three or four months for the same gentleman, Senor Placide Gener, of Matanzas. They are all intended for sugar plantations.

The Plate Glass Trade.—The whole of the manufacturers of plate glass in this country have coalesced and formed one joint-stock company, with limited liability.

It is said that Government has consented to sanction a new degree to distinguished men of science—Doctor of Science.

Watt and Park, the engineers of the *Cagliari*, have arrived in England.

Mr. Moyle, C.E., who has for many years been connected with the Morfa Copper Works, Swansea, has been appointed by the Admiralty conductor of the metal mills in Chatham Dockyard.

A New Gasometer has been completed at Bury St. Edmund's. Depth of tank, 18 ft. 6 in.; diameter, 51 ft. Erected under the superintendence of Mr. Jabez Church, of Chelmsford, and Mr. G. R. Burnell, of London.

A Turbine, or Patent Vortex Wheel, has been erected at Holywell Hall Mill Works, near Stamford, by Mr. C. B. Reynardson, for the purpose of driving, sawing, and grinding machinery.

Reigate.—Messrs. Easton and Amos have contracted to complete the waterworks.

Mr. Henry Smith, of Birmingham, and Mr. Willey, Liverpool, have obtained £1,358 damages from the Caledonian Railway Company, for having wrongfully used a patent for making wrought-iron wheels which had been assigned to these gentlemen by the inventor, Thomas Day.

An Explosion of Steam Coal has occurred on board the barque *Ellen*, of Liverpool, while at anchor in the river at Swansea. The deck was shattered to pieces, the bulwarks and midships blown out, and the rigging much damaged.

The Expenditure on the Repairs of Roads, &c., in the districts around London, north of the Thames, for the year ending Lady Day, 1857, amounted to £64,233.

The late Mr. John Seaward.—Another of the notabilities of the scientific and engineering world has been recently removed by the death of this gentleman, which took place on Friday, the 26th of March, at his residence at Camden-town. Educated as an architect and surveyor, he distinguished himself by various papers and communications on subjects connected with engineering, chemistry, &c., by which he was early brought into connection with Sir Humphrey Davy, Thomas Telford, Daniel Gilbert, and other eminent men of the day. He attracted attention at the time by an original design for the New London Bridge, and soon afterwards became extensively engaged in the design and construction of iron bridges and docks, also in the development of lead mining in Wales, and subsequently in the extension of gas-lighting on the Continent. In the year 1825 he established, in conjunction with his brother, the large manufactory for steam-engines at Limehouse known as the Canal Iron Works, at which an immense number of engines of the largest size have been produced to the present time. Space will not permit a detail of the various inventions of Mr. John Seaward for the improvement of the marine engine; but the most important will be considered his design for superseding the heavy beam-engine (as left by Watt, and up to that time the only kind used in large ships) by a plan of direct-acting engine which, having been fitted into a Government vessel, called the *Gorgon*, originated the now universally known title of the "Gorgon engine," and Mr. Seaward, in consequence, soon became extensively engaged in the design and construction of numerous engines on his plan for the British Navy, &c. His improvements in the detail of the steam-engine are numerous. In private life he was singularly amiable and unostentatious.

RAILWAYS, &c.

The Metropolitan Railway.—It seems probable that we may at last get something approaching to the railway accommodation necessary for a city like London. It was resolved at the last meeting of this Company to commence immediately, and vigorously prosecute the works on this line, which is to unite the Great Western, the London and North Western, and Great Northern Railways, and connect them with the Post Office and the heart of the city.

The West-End of London and Crystal Palace Line has been opened.

The Bow and Barking Line has been opened.

Portsmouth.—Messrs. Lock and Errington report that from Godalming to Haslemere, a distance of 9 miles, all the works are nearly finished. From the latter place to Langley, 7 miles, the works are almost completed. Between Langley and Petersfield, five miles and a half, some earthworks are yet unfinished; and thence to Havant, 11 miles, the work is in a forward state. All the earthworks throughout the entire line will be completed in two months. 26 miles of permanent way have been laid, of which a great portion has been ballasted. The remainder will be completed as the earthworks proceed.

The Salisbury Station of the South-Western Railway has been destroyed by fire.

Salisbury and Yeovil Railway.—Workmen are busy laying 10 miles of the road between Wilton and Gillingham, which are now ready for the permanent way. The works between Salisbury and Wilton are proceeding, and the heavy cuttings at Temple Combe and Melbourne Wick are commenced.

Railway Tunnel at the Dover Heights.—The tunnel in the course of construction by the East Kent Railway Company, under the heights, is in rapid progress, the workmen being at present employed in bricking the arch and sides as fast as the miners remove the chalk and earth from the tunnel. A clear passage through has been for some time effected, and about three-fourths of the completed tunnel have been constructed so as to require little more than the ballast and rails to be in a working condition. The entrance from Canterbury is on the Folkestone Road, which, ere long, will be lowered 11 ft. The length of the tunnel is about 680 yards; the clear breadth is 31 ft. 6 in.; and the height, from the rail to the keystone of the arch, 21 ft. 6 in., all of well-finished brickwork, 18½ ft. thick. The greatest depth, from the surface of the heights to the rails, is from 270 ft. to 280 ft.

Bristol and South Wales Junction.—The first sod is to be cut about May 1.

South Durham and Lancashire.—Rapid progress is being made with this line, on which there are some heavy works.

Border Counties.—The first section, from Hexham to Wall and Chollerford, has been opened.

South Durham and Lancashire.—The works are progressing rapidly.

Staffordshire and South Wales.—Arrangements are in progress for the formation of a company to construct a line connecting the iron districts of Staffordshire with South Wales.

Boston and Sleaford.—A commencement has been made.

Elgin to Inverness line has been opened.

Fife and Kinross.—Seven additional miles, from Strathinglo to Melnathort, have been opened.

Bagenalstown and Wexford.—The works on the first division have made considerable progress; six miles were brought to formation level, and two were ballasted.

Limerick and Castle Connel Railway.—It is intended to extend this line seven miles.

A new line, the Leitrim and Lough Allen Pier, is projected.

Dublin and Meath.—This line will be twenty-three miles long. An extension of 25 miles is proposed from a junction with Ballynahinch branch to a junction with Dublin and Belfast Railway, in the townland of Drumartine.

A new line is to be made, on the west coast of France, from Bordeaux, through Rochelle, Brest, and Nantes.

The Lyons and Geneva Line, which unites France with Switzerland and Sardinia, and gives direct communication between Paris, Italy, and Germany, was opened on the 16th March.

Thiouville and Luxembourg are about to commence. Contractors: Sturel and Co., of Metz.

The Lapallis and Roanne line is to be opened in June.

The Cambrai and St. Quentin is to be opened in July.

Seville and Cadiz Lines.—The works are much advanced; all the land has been purchased; the earthworks, masonry, and guard houses, &c., are finished for double line for 90 kilometres in length. The materials for the telegraph are on the ground, as are also the sleepers, rails, and fishes, for 22 kilometres. The ballast is ready, and the first delivery of engines and waggons, which took place lately, enables the line to be ballasted rapidly, and the permanent way to be completed. Everything permits the Company to hope for the completion of all the line at the end of this year. The section of Cadiz to St. Fernando is expected to be opened next May.

Belgium, Ecaussines, and Erquelinnes.—The works are in active progress.

The Francis-Joseph Eastern Railway of Austria has sent an order for thirty locomotives to a factory at Essling.

Proposed German Lines.—1. Extension of the Waldeshut Railway to Constance; 2. Durlach by Pforsheim to Wurtemburg; 3. Junction of the Baden Railways with those on the left bank of the Rhine, near Kehl and Waldeshut; 4. Heidelberg to Nosbach; 5. Offenbourg extensions.

The works of the Schweinfurt (Bavaria), Bebra and Fulda (Hesse Cassel), are to commence shortly.

The Northern Railway of the Tyrol is to be opened on the 14th of October. The Linz and Passau line will be finished within the prescribed time.

The Great Tunnel under the Alps, near Modane, proceeds with uninterrupted activity. At that end the heading is driven 85 mètres—at the Bardonniche end more than 100 mètres have been done, and as the rock is very hard, full section is being taken for a length of 60 mètres.

Royal Swedish.—The line has been opened from Orebro to Arboga—34½ miles.

The Russian Government has just given a contract for a line from Ribuisk on the Volga to St. Petersburg.

The "Journal de Charleroy" states that the contract for rails for Russia amounts to 176,000 tons. England is to supply 136,000 tons; France, 40,000.

The Railroads in the United States now open extend to 25,000 miles.

Turkey—Aidin.—The natives were astonished on March 23rd by the first locomotive making its trial trip.

The Scinde Railway Company have paid to the East India Company £350,000 on account of capital for the Punjaub Railway from Mooltan to Lahore and Umritsir.

Bombay, Baroda, and Central India Railway.—It appears that the earthworks of 150 miles of this line, from Surat to Ahmedabed, are on the point of completion; that several miles of the permanent way have been laid down, and the engines were at work ballasting the line. The first large iron bridge on this section was nearly completed. The working drawings were being prepared for the section lately conceded to the company between Surat and Bombay, preparatory to the commencement of the works.

Cape Town.—The survey has been completed.

Geelong and Melbourne.—The proposal for the sale of this line to the Colonial Government has been agreed to.

The Grand Trunk Railway.—The Grand Trunk Company has been busy during the whole winter in making preparations for the completion of the road as far as Riviere du Loup, 75 miles below St. Thomas, its present eastern terminus. Materials for fencing, culverts, bridges, &c., have been in the course of delivery for some time, so that in the spring no delay will be encountered, and the work pushed on at once. It is anticipated that in the summer of 1859 the whole distance from Quebec to Riviere du Loup, 120 miles, will be completed.—*Canadian News.*

TELEGRAPH ENGINEERING, &c.

Telegraphic communication has been established between Penzance and Plymouth.

It is in contemplation to lay down a submarine telegraph between the isles of Portland and Jersey, touching at the isles of Alderney and Guernsey.

The Atlantic Telegraph.—The cable is again being stowed on board the *Agamemnon*. A new form of brake, invented by Mr. Appold, is to be used.

The American Telegraph Company now sends despatches from both ends of the line, and simultaneously, by a single wire, the electric currents meeting and crossing, but causing no irregularity. Two ordinary cells of the Grove battery are used. This is the invention of a Mr. Hughes.

The line connecting Sydney with the South Head, Port Jackson, on the one hand, and Liverpool, the present terminus of the Great Southern Railway, on the other, was opened to the public on January 26th. The line from Melbourne to Beechworth has also been opened.

MILITARY ENGINEERING.

The embrasures of the fortifications commanding Southsea Common and the approaches to King William's Gate, Portsmouth, have been heavily armed.

Berwick.—The ramparts are to be heavily armed with 95-pounders. Holy Island is also to be placed in a state of defence.

The roadstead of Copenhagen is to be fortified.

Experiments are now being made at Vincennes with a new description of cannon, with which the new French ships of war are to be armed. The guns are to be of bronze.

Trial of Iron Facings for Garrison Batteries at Woolwich.—A huge block of wrought iron, about 6 ft. by 5, and weighing about 7 tons, was placed against a small battery, erected for the occasion, and withstood the fire of a couple of 68-pounders, fired from a distance of 600 and 400 yards, for upwards of four hours, exhibiting a few slight indentations only.

Eighty Pieces of Cannon have been cast at Liège for the Sultan.

Iron for Heavy Ordnance.—After several experiments at the Royal Standard Gun Foundry, Woolwich Arsenal, the select committee have recommended that such guns should be cast from a mixture of Swedish and Nova Scotia iron.

MARINE ENGINEERING, SHIPBUILDING, &c.

Accident to the "Leviathan."—During a sharp north-easterly squall, which swept up the river with considerable violence on Monday, April 5, the moorings of the great ship were subjected to a most severe strain—a strain under which some of those on the port bow at last gave way, and for a time exposed the vessel to a certain amount of peril. Ever since the vessel has occupied her new berth near Deptford, her moorings have been more or less severely tested, and on one occasion, which occurred a few days after her launch, she swerved to such an extent into the centre of the river, that two of the largest of Trotman's anchors, which hung at her bows, had to be immediately let go to check her. With the additional security which the immense strength and tenacity of these anchors afforded, her position was believed to be perfectly secure, as far as regarded any further dragging. It seems, however, that the mooring chains, strong as they were, were not able to resist the immense strain exerted by the wind upon the vessel's side—a pressure which at some moments must have amounted to at least 500 tons upon the whole surface. Under this great strain, one of the mooring-chains on the port bow parted about 20 ft. below the hawse-hole, and threw such an unfair weight upon the others, that a second stem-chain broke, and allowed the vessel's bows to swing in towards the Deptford shore. Mr. Prowse, the chief officer, who has charge of the vessel, immediately took every precaution to secure her safely. Under his direction some large hawsers were taken out, and made fast to the stern-moorings of the new *Dreadnought* hospital ship, which kept the vessel from further drifting, and then, with the assistance of three powerful tugs, her head was again hauled round into her old position. Some additional mooring-chains of great strength were also procured, and with these she was made fast beyond the chance of further accident.

Two Floating Batteries are about to be laid down, one at Toulon, the other at Brest, both cased in iron. Two helmsmen will be protected by a bullet-proof tower, on the top of which riflemen can be accommodated. They are to be propelled by screw engines of 1,000 H.P.

The Neapolitan Fleet is composed of 16 sailing and 29 steam vessels, mounting 746 guns in all. The Sardinian fleet consists of 6 sailing and 12 steam vessels, mounting 316 guns.

Judge Hall, in the United States Circuit Court, has made a decision denying the motion on the part of the Government for an injunction to prevent the sale of the Collins steamships; and on the 1st of April, the *Atlantic*, *Baltic*, and *Adriatic*, were sold by the sheriff on the pier near which they were moored. There was only one bidder, Mr. Dudley B. Fuller, and they were knocked down to him, with all their tackle ready for sea, at 50,000 dollars. The "New York Herald" says:—"Mr. Fuller proved to be a member of the firm of Fuller, Lord, and Co., iron merchants, corner of Cedar and Greenwich streets. There seemed to be some curiosity to find out for whom he purchased the steamships. No one thought that he bought them for his own firm. The general impression was that they were bought in for James Brown, one of the present company. At all events, the purchaser got a decided bargain. All the claims against these ships amount only to 657,000 dollars, which, added to the 50,000 dollars paid for them—supposing all the liens to hold good—makes the price of the three fine steamships *Baltic*, *Atlantic*, and *Adriatic*, 707,000 dollars. The *Adriatic* alone cost over a million, so that the value of the three cannot fall short of two millions and a half."

Iron Steamship building at Southampton.—A very fine iron screw steamer, built for the Peninsular and Oriental Company, has been launched from the yard of Messrs. Summers and Day, iron shipbuilders and engineers, at Northam, Southampton. The *Northam* is built and engined entirely by Messrs. Summers and Day, and is the largest iron steamship yet built at Southampton. Her dimensions are as follows:—

	ft.	in.
Length between perpendiculars	274	0
Length over all	300	7
Breadth	34	6½
Depth of hold	26	0
Tonnage (builder's measurement)	1,607	21·94

She is a spar-decked ship, and has a large topgallant forecastle for the accommodation of the crew; an elliptic stern, and female figure-head. Her rig is somewhat peculiar, as her three lower masts are very taut, and are each fitted with powerful topsails, which lace to the booms, as in fast schooner yachts, for the purpose of sailing close to the wind. At the same time she carries square sails on her fore and mainmasts, which can be used when running before the wind, or sent down when head to it, as also can the topmasts, thus presenting little resistance. She has very roomy berths, and can accommodate 97 first and 30 second class passengers. We noticed a very simple but ingenious plan by which greater ventilation for the cabins is provided than by the ordinary arrangement of jalousies. These are so fitted that they can be completely closed by the passengers when privacy is desired, or thrown wide open to the saloons, and thus allow a free current of air to sweep through the side ports into the interior of the vessel. This improvement has, we are informed, been suggested by Captain Engledue; and we have no doubt that the passengers in hot climates will be much benefited by it. No trouble appears to have been spared by the builders of the *Northam* to make her efficient in every respect; and her scantling is considerably greater than is usual in vessels of her tonnage. The four water-tight bulkheads are particularly substantial, and are tightly caulked, with the same care that is usual in boiler making. The engines are of 400 H.P. (nominal), and direct acting. The boilers are fitted with Lamb and Summers' patent flues, and are in four pieces, which

will unite into one chimney. This machinery will be fitted in the Southampton docks, and the vessel will probably be ready for sea in about six weeks.

TO COMPLETE THE "LEVIATHAN," so as to enable her to proceed to sea, will require an outlay of £172,000. The total cost is estimated to be £804,522, or at a rate of £34 per ton, taking it at builder's measurement, 24,000 tons.

"THE LEVIATHAN."—It is hinted by a Liverpool paper that this vessel is in the market for sale, in her present incomplete state.

THE SCHOONER "GEORGE" has arrived at Liverpool, from Lairdstown, with the first cargo of produce from the river Niger. It consisted of palm oil and ivory. Lairdstown is 600 miles from the mouth of the Niger.

TWO SMALL STEAMERS have been constructed on the Thames for the navigation of the river Tiber, between Ostia and the Eternal City.

THE TURKISH GOVERNMENT have just completed contracts with three English shipbuilders and three London engineers for *ten war steamers*, ranging from 2 to 800 tons, to establish the Black Sea Fleet allowed to them under the Treaty of Paris. It is thought that the total cost will be little less than £300,000.

MESSRS. SHAW, SEWILL, AND CO. are about to despatch from the Thames two steamers to commence the Mail Service between the Australian ports and New Zealand.

NORTH SHIELDS.—Messrs. T. and W. Smith have just launched an iron auxiliary screw steamer of 1,200 tons, the *Havelock*. Length, 200 ft.; breadth, 30 ft.; depth, 18 ft. Engines, of 90 H.P., by Messrs. R. and W. Hawthorn, of Newcastle.

THE SHIELDS STEAM FERRIES have been fitted with new apparatus for the consumption of smoke.

THE DESTRUCTION OF STEAM SHIPS BY FIRE appears to be of frequent occurrence in the United States. The steamer *Sultan* was burned to the water's edge, and sank near St. Genevieve Mobile on the 2nd instant.

THE FRENCH NAVY.—Two frigates are to be constructed on the lines of the *Audacieuse* and *Imperieuse*, with plates of iron inserted between the planks. Experiments have beenmade at Vincennes, which have resulted in the adoption of this plan.

FRANCE will possess, in the year 1859, an effective force of 150 war paddle and screw steamers of great speed, independently of the sailing ships of war, fitted with screws. These 150 war steamers will be composed of ships of the line, frigates, corvettes, and cutters. Neither gun-boats, steam transports, floating batteries, nor fire-ships, are included in this number of 150.

CHERBOURG.—M. Reybill, Chief Engineer of Hydraulic Works, and M. Dupuy de l'Orne, Director of Naval Constructions, have been sent to Cherbourg, by order of the Emperor, to ascertain the precise time at which the dock can be opened.

GUN-BOATS FOR THE BRAZILS.—Eight are building on the Thames, and two in France, for coast and river service in the Brazils. The armament of each boat is six guns; complement of men, 200. Each vessel will carry two boats fitted with Clifford's Lowering Apparatus.

A Liverpool paper states that a NEW STEAMER FOR ROCK FERRY has been launched at Paisley. She is named the *Wasp*, and will be a companion to the *Ant* and *Bee*.

TURKISH STEAMERS ON THE TIGRIS.—In addition to the small steamer *Omnibus*, mentioned in our last at page 98, the *Harriet Hoxie* will carry out a small steamer, built at Havre by M. Normand, to ply on the Tigris between Bagdad and Bussorah.

AUSTRALIAN MAIL SERVICE.—The West India Royal Mail Company's steamers will be employed in the service between Southampton and Alexandria, and the *European*, *Columbrian*, *Emeu*, *Victoria*, *Australasian*, *Oneida*, *Tasmania*, and a new steamer about to be completed, will be placed on the Australian line.

CHATHAM.—The *Mersey*, screw steamer, now being built at Chatham, is pierced for forty heavy guns, and from her immense length and the great power of her engines, 1,000 horse, great speed is anticipated. She is to be launched in June.

A NEW 22-gun steam screw corvette, to be called the *Orpheus*, is ordered to be laid down, and a large line of battle screw steamer, on the slip lately occupied by the *Hero*.

WOOLWICH.—The screw-steam corvette *Challenger*, engines of 400 H.P., by Penn, got up steam April 22nd for the purpose of trying the machinery, which was kept working in the basin five hours.

HER MAJESTY'S store transport *Dee*, in Woolwich basin, has commenced shipping a newly-organised invention, brought forward by the Engineer officers of the dockyard for superheating steam. The apparatus hitherto used on board that vessel for mixing superheated and plain steam is ordered to be removed, and the new apparatus to be fixed entire. According to a report of some experiments entered into for the satisfaction of the Board of Admiralty, the new invention affords the advantage of superheating the whole of the steam required for propelling the machinery without the admixture of any portion of the ordinary steam. An arrangement of tubes, such as has been heretofore employed, has been considered inconveniently adapted to steam boilers, and instead of causing the steam to pass through a series of tubes to be superheated, the present invention conveys it through chambers or boxes, which may be adapted in size and form to any convenient part of the boiler, and may be heated by the flame issuing from the furnace or fireplace before passing into the flue. The boxes are connected together in such a manner as to cause the steam to circulate therein in a serpentine direction, so as to bring it in contact with as great an amount of heating surface as possible. The superheated steam is conducted to a mixing chamber or slide-jacket, where it may be combined with common steam before being passed into the cylinder of the engine. The mixture of superheated steam with common steam does not, however, appear to form a part of the present invention, which simply consists of a novel construction or arrangement of the boiler, in which steam may be superheated, or superheated steam may be produced, and applied in any manner that may be desired.

THE launch of the large line of battle screw steamer, *Hero*, 91, took place at Chatham dockyard lately. The *Hero* has been on the stocks nearly four years, having been laid down on the 8th of June, 1854, and was built from the designs of Admiral Sir Baldwin W. Walker, K.C.B., Surveyor of the Navy, under the direction of Mr. F. J. Laire, the master shipwright at Chatham dockyard, and his assistants. She is one of the finest vessels of her class ever constructed for the British navy. The following are the proportions of this splendid vessel:—Extreme length between perpendiculars, 234 ft. 4 in.; length of keel for tonnage, 199 ft. $3\frac{1}{2}$ in.; extreme breadth, 55 ft. 4 in.; breadth for tonnage, 54 ft. 6 in.; breadth moulded, 53 ft. 8 in.; depth in hold, 24 ft. 6 in.; burden in tons, 3,148 28-94ths. The following will be the armament of the *Hero*:—Lower deck, 34 8-inch guns, 65 cwt., 9 ft. long; main deck, 34 32-pounder guns, 58 cwt.: 9 ft. 6 in.; upper deck, 22 32-pounder guns, 45 cwt., 8 ft. 6 in.; ditto (pivot), 1 68-pounder gun, 95 cwt., 10 ft. Immediately after the launch the *Hero* was towed by the *African* and *Lizard* steamers to Sheerness for the purpose of having her engines put on board, her machinery being of 600 H.P. The next vessel to be launched at Chatham dockyard is the large screw steam frigate *Mersey*, 40, which is very nearly completed.

THE STEAM YACHT "FANTASIE" (see p. 9 of the present volume), which has, during the last few months, been in process of construction for the Emperor of Austria, at the London Shipbuilding Company's Works, at Blackwall, proceeded down the river March 31st to try her engines. She is well suited, by her light draft of water, for navigating the Danube, and traversing the shallow and smooth waters of the Adriatic. She is 180 ft. in length between perpendiculars, with an extreme beam of 18 ft., but is rather shallow for these dimensions, being only 11 ft. 6 in. in extreme depth of hold. She is 290 tons, builder's measurement, and a draft of 6 ft. 6 in. gives 280 tons displacement. Of course, to obtain such a light draft of water the ship's bottom had to be constructed almost flat, and something of her speed had to be sacrificed by the enlarging of the bows and stern; but it was an imperative condition that she should float well in 6 ft. water. Her run, fore and aft, is not, therefore, quite so sharp as one would be inclined to expect in a Royal yacht. This is amply compensated by the increased internal room which is thereby obtained. The principal saloon is of course aft, and is reached through a handsome oval deck-house; the saloon is about 16 ft. square, and about 8 ft. high. The decorations are of white and gold, and the walls are adorned by numerous elaborate console mirrors. The furniture of the cabin is of walnut wood and crimson satin damask. Aft of the state saloons are placed the sleeping berths of the Royal attendants, and fore of the saloon are the two state sleeping apartments, a bath-room, and a small boudoir, to be used as a writing-room and library. In the fore part of the vessel are the officers' mess-rooms and berths. Pipes for the conveyance of hot and cold water, and bell wires, are carried through every part of the ship. Her engines, which are by Messrs. Rennie, are of immense power, to counteract the necessary adverse condition as regards speed under which she was built. They are of 120 nominal H.P., and are trunk engines, to avoid the immense vibration which would be caused by the oscillation of such large cylinders. The cylinders are 51 in. in diameter, which, deducting the surplus of the trunk, which is 24 in. in diameter, leaves an active surface of the piston of 48 in. diameter. The steam is supplied by two boilers, each of which is heated by three furnaces, and traversed by 750 hot air tubes. The steam-generating power of the boilers is much greater than is required for the engines, even when working at full speed. The air-pumps and condensers, and the donkey-engine gear, are constructed on the same plan as those of the *Candia*, *Pera*, and several other large ocean steamers. The stroke of the engines is 33 in., and when working full power, they will make thirty-five revolutions per minute. The diameter of the paddle-wheels is unusually great for the general dimensions of the vessel, being 35 ft. 2 in., and of course, owing to the great shallowness of the boat, a considerable proportion of this diameter is raised above the deck. She has two funnels, which, as well as her two masts, rake considerably, which, with her enormous paddle-boxes, give her an appearance of great swiftness. In other respects her general aspect is not unlike that of the *Banshee* and *Caradoc*. The general average of all the trials gave a speed of about 14 knots an hour, though the runs were performed under manifestly unfavourable circumstances. In the first place, the engines were new, and had not come well to the bearings; secondly, she was laden 6 in. deeper in the water than the stipulated draft; and, thirdly, the violence of the wind prevented anything like a fair trial of her capabilities being made. It was therefore agreed to give her another trial, under more favorable circumstances. The iron floats of her paddle-wheels are constructed of great strength and solidity, in consequence of the great quantity of "snags" and floating timbers which are to be met with in the Austrian rivers. The ship was built under the superintendence of Messrs. Rennie; but at the same time it is only fair to that firm to state that such stringent conditions were imposed upon them, as regards the length, breadth, and draft of water of the vessel, that it was impossible for them to fulfil the required conditions and build a clipper yacht at the same time. She is only guaranteed to steam $14\frac{1}{2}$ knots an hour, with a 6 ft. draft of water.

A LINE OF STEAMERS is about to run between Mobile and other ports in the Gulf of Mexico and San Juan de Nicaragua, for the purpose of conveying passengers and emigrants to Nicaragua.

HARBOURS, DOCKS, CANALS, &c.

PORTSMOUTH.—The attention of the Lords of the Admiralty has been directed to the unfinished state of the North Inlet Dock. It is said that £50,000 would complete this necessary work. It was left unfinished by Mr. Rolt. The great dock at the other end of the dockyard, about 650 ft. long, is progressing rapidly, under the superintendence of Mr. G. Smith, C.E., and will speedily be completed.

DOVER.—The Admiralty Pier, if carried out according to the plans proposed, will afford shelter to and anchorage for above 200 ships. The pier already extends several hundred feet into the sea, and has given proofs of its strength by withstanding storms. Messrs. Lee are the contractors. Below the surface of the water, operations are going on, and soon an additional 100 ft. will emerge from a depth of 10 to 13 fathoms, at which depth the foundation is laid in chalk.

COWES.—There is a strong feeling in favour of deepening the harbour here.

GREAT YARMOUTH.—A new pier is being constructed here, under the superintendence of Mr. A. W. Morant, C.E.

THE LIVERPOOL DOCK AND HARBOUR BOARD have resolved to make a line of rails in connection with the north side of Stanley Dock to the London and North Western Railway.

BLYTH HARBOUR.—The entrance has been improved lately by means of dredging.

THE formation of piers at the mouth of the Tyne is proceeding vigorously, and the docks at Tanon are progressing.

A HARBOUR OF REFUGE is to be formed at Portrush, Ireland. The two Skerries are to be united, and a breakwater is to run out from Ramore Head, leaving a sufficient space between it and the Skerries for the egress and ingress of vessels. A lighthouse is to be erected on the rocks opposite Dunluce, called the Stirks.

The NEW JETTY AT AGHADA PIER has been commenced.

PATENT SLIP DOCK, of 3,000 tons register, in the harbour of Kingston.—Mr. Miller, (of the engineering firm of Bell and Miller, Glasgow), who has made the necessary preliminary surveys, has reported that, owing to the extremely favourable conditions of site, the entire work, assuming all expenses to be borne by the company, might be completed for £30,000. Were convict labour, however, to be afforded, as it might well be, considering the public importance of such a work, there is every reason to believe that £25,000 would complete it. When it is considered that there is no slip in the West Indies on which a vessel of any heavy draft can be hauled up for examination and repair, there can be little doubt that the projected dock in this harbour would be a highly profitable work, whilst its benefit to the trade of this island would be immeasurable. In THE ARTIZAN Numbers for March and November, 1853, will be found drawings and description of Miller's Patent Slip.

JARROW DOCKS.—The contractors have commenced to dredge the outer or river entrance to the principal basin.

THERE exists a continuous water-way by rivers and canals between the Black Sea, by the Danube, Rhine, Seine, and the ocean at Havre. A similar junction by inland navigation is now in project, or in progress, between the Black Sea and the Baltic, through the Vistula, falling into the one, and the Dneister into the other, the intermediate level land being now under canal work. This is an immense step for Russia in the right direction.

THE Porte has rejected the demand made by the French Ambassador for the authorization for the cutting of the CANAL THROUGH THE ISTHMUS OF SUEZ.

BRIDGES.

VENICE.—On the 3rd inst., the new iron bridge crossing the grand canal, near the railway station, was opened to the public, after being subjected to a test equal to a thousand lbs. on the square metre of platform. It is a light and elegant construction, built upon iron cylinders on the "Neville system." Some difficulties occurred in sinking the cylinders, owing to a fresh-water spring being discovered under one of them, but this being promptly overcome, the construction, under the active superintendence of Mr. Neville, the son of the inventor of the system, was carried on with great celerity, until its conclusion, and now Venice can boast of possessing three large bridges over the grand canal.

RAILWAY BRIDGE OVER THE SOANE.—The bridge now in course of erection on the East Indian Railway, across the river Soane, not far from its junction with the Ganges, consists of twenty-eight clear spans, of 150 ft. each, and its total length will be 4,700 ft., or seven-eighths of a mile. The superstructure is entirely of wrought iron, and has been manufactured in this country by Messrs. W. G. Armstrong and Co., of Newcastle. The rails are laid on the tops of the girders, which are of a lattice construction, specially

designed with a view to their easy transport to, and re-erection in, India. The space beneath the rails forms an excellent way for foot passengers. The piers are founded on the Indian method, on wells sunk through the sandy deposit, which forms the bed of the river for some depth, to a lower stratum of clay. Each pier will be supported on twelve such wells, domed over and built up together solid above the lowest water level.

Carmarthen and Cardigan Railway Bridge.—The operation of floating the girders has commenced. The contractors are Messrs. Finch and Heath, of the Bridge Works, Chepstow, and the bridge is from the plans of I. K. Brunel, Esq., and erected under the superintendence of Messrs. R. Brodie and C. Weeks, Civil Engineers, of Carmarthen.

Mr. Gibbons, C.E., has approved of the designs and plans of the contemplated bridges over the Boyne, as furnished by Mr. Bowers, C.E.

Stockport.—The Vernon Bridge has been condemned as dangerous; the approaches have been blockaded, and a portion of the bridge removed. The contractors for the new erection are Messrs. Thackeray and Pierce.

The Victoria Bridge at Montreal.—Considerable activity is just now displayed on the ice along the line of the Victoria Bridge, the level surface of the icy plain being covered with timber-work for the cofferdams, and cribs for the piers, to be constructed next season. It is intended to sink the cofferdams through the ice, in openings made for that purpose, and thus avoid delay in prosecuting the work in the spring. Nine piers are thus being prepared, and these are intended to be finished during the current year, leaving only three to complete the number necessary. By the close of 1859 we shall, in all probability, see this gigantic undertaking in process of completion, or nearly approaching thereto. The tube connecting the abutment on the south shore with the first pier on that side, which was commenced in the early part of the winter, is rapidly assuming its place and spanning the interval between. An indicator has been placed in conjunction with the completed tube on the north shore, to mark the expansion or contraction of the metal in the rapid changes to which our climate is subjected.—*Canadian News.*

The testing of the final portion of the Bombay, Baroda, and Central India Company's iron bridges took place April 21st, on the premises of Messrs. Baillie, Campbell, and Westwood, Isle of Dogs. The girders were 60 ft. span, and constructed with a view that every pound of iron should do its full work. A load of 130 tons was placed in trucks, being about four times the load the bridge could possibly have to bear, being 2 tons per foot. The following figures show the deflection of the first girder under given weights:—The first load of 15½ tons produced a deflection of nearly 3-16ths of an inch; the second load of 31 tons, 5-16ths of an inch; the third load, 46 tons, 7-16ths of an inch; the fourth load, 62 tons, 8-16ths of an inch full; the fifth, 79½ tons, 9-16ths of an inch; and the sixth, being a total load of 164 tons, produced a deflection of 5-8ths of an inch. On the second girder of the bridge the figures slightly varied, owing to some inequality in the loading. The load was then removed, a bolt withdrawn, but no permanent set was observable. The experiment was in every respect most satisfactory.

BOILERS, FURNACES, SMOKE PREVENTION, &c.

Boiler Explosion.—On April 2nd a boiler explosion took place at the Iron-works, Congreaves, Dudley, belonging to the New British Iron Company, by which six or seven persons were injured, one or two of whom are not expected to survive. The exploded boiler was one of three used in connection with each other to drive the engines of the forge. It was cylindrical in shape, about 30 ft. long, and had flat ends. The men were at work as usual on Good Friday, when a loud report was heard, and a large body of water and bricks and pieces of iron were scattered over the works. On examination, the middle of the three boilers was found to have exploded, and one of its flat ends to have been forced away, the brickwork by which that portion of the boiler was covered having also disappeared. The end at which the explosion occurred was within 2 or 3 ft. of a large engine-house, and but for which the damage to property and loss of life must have been considerable. The engine-house, however, broke the force of the explosion, and the bricks and ironworks there seem to have taken a sideward course, one of the pieces of the iron-work being blown into the air, and carrying away a portion of the roof of another engine-house, 20 or 30 yards off. The scalding water which the boiler contained at the time took a similar direction, and inflicted much injury. The engineer was in his engine-house at the time, and was saturated with water, but, strange to say, not scalded. The water reached him by being blown through one of the engine-house windows. The boiler is said to have been in use for some years, and to have recently undergone repair. It was the angle-iron round the end of it which seemed to have given way. The men state that the engine was at work at the moment of the explosion, and had been for some time prior.

A Galloway Boiler has Exploded at Lincoln, at the flour mills of Keyworth and Seeley.

MINES, METALLURGY, &c.

A valuable Lead and Silver Mine has been discovered at Snowbrook, at the base of Plinlimmon, about 8 miles north-east of Llanidloes. A sample of the ore has been assayed; it produced 80 per cent. of lead, and 20 oz. of silver to the ton of lead.

The Burra Burra Copper Mines, Australia, now give employment to 1,013 miners, and support a population of nearly 5,000 persons.

Mining will shortly be commenced on the Marquis of Huntley's estate at Orton, near Peterborough, where iron ore has been found.

NOTICES TO CORRESPONDENTS.

Q.—The best work we know upon the subject suited for your study is published by J. W. Parker, West Strand, "Hydrostatics, &c.," by Thomas Webster, M.A., &c. We believe there was a fourth edition published last year.

R. C.—We do not now know the address of Mr. Huddlestone, and cannot inform you thereof, nor can we forward the letter if sent to us; we believe he has been dismissed the service, and none of the company's officers to whom we have applied can aid us in your behalf.

J. (Agra.)—We think the following books should be selected:—"The Assistant Engineer's Railway Guide," by W. D. Haskoll, C.E.; "The Engineering Field Notes, &c.," by H. J. Castle; and F. W. Simm's "Treatise on Levelling, &c.," John Weale, 1856. The last-named is an excellent book. The first two may be bought cheap at Spon's, Bucklersbury.

C.E.—The thing you refer to has been patented at least a dozen times to our knowledge, and if you will refer to the list of patents published in The Artizan, you need not incur the expense. If you will send your address by post, we shall be happy to obtain the information, and forward it to you.

J. C. P. inquires in what trades or manufacturing operations steel wire has been ordinarily hardened and tempered before the final process of drawing through a draw-plate. The question applies to hardening and tempering by heat, and not hardening by condensation produced either by drawing, rolling, or such-like manipulation; and whether the wire so treated is reduced in diameter by one or more holes after it has been so hardened and tempered. We shall be very much obliged to any of our readers who will take the trouble to inform our correspondent, through us, without delay. We believe that the particular process referred to has been long practised in the manufacture of music wire, and also watch pendulum springs, and other flat steel wire or ribbons; and we think we remember some years ago being informed that the same process was applied to the manufacture of pinion wire.

T.—Hull.—The Atlantic Telegraph Cable will, it is anticipated, be again got ready for submersion about the end of May, or the beginning of June, and will await the first favourable opportunity. It is said that the *Niagara* and *Agamemnon* will, early in August, each steam for the centre of the Atlantic, between the two points which are to form the terminal stations; and having joined the end of the cable from each ship, the bight will be thrown overboard, and one ship will make for England, and the other for Newfoundland. The paying-out machinery is already constructed, and is now being exhibited at the works of Messrs. Easton and Amos, in Gravel Lane. Your plan of paying out cable certainly would not have been adopted by the company; its construction is based on an erroneous supposition, and is defective from a want of a practical knowledge of the subject.

N. P. Burgh (Engineer).—Your letter, dated February 27th, had been put away amongst the letters answered. If you will send specimens to the office, addressed to the Editor, accompanied with all particulars, it will receive attention. There is some probability of the opportunity occurring very shortly.

R. Roberts, C.E.—Thanks. Received too late for this month.

H. B.—Received with thanks. As we could not advise you to patent the apparatus, it was used as directed. The particulars of power-loom respecting which you inquire shall be sent, as also the prices, &c., of Kennedy's water-meter. Would not Perreaux's valves, illustrated in this month's journal, be very applicable in many situations under your direction?

D. E. C.—We recommend you to apply to the locomotive engineer of the Brighton Railway Company.

D. (New York.)—All in good time. The *Leviathan* is now being completed. The contracts for her internal fittings and decoration have been given out. The remainder of the Plates connected with the *Leviathan* will be published shortly, we being considerably in arrears with other subjects.

C. K. (Ipswich.)—If you will furnish us with particulars of what you really require, and your expectations, we think something may be done for you with an engineer to whom we have spoken on the subject. Write by post as early as convenient.

J. Kennedy (Newport).—We have not been able to learn anything satisfactory with reference to Mr. Betz-Penat's maize grinding machinery, but some of our readers may be able to inform us respecting the invention, and where it is at work. We are much obliged for your politeness, and are glad to find that our efforts are appreciated.

Ignoramus (Stoneham, Devon).—We had hoped ere this to find time to reply to your inquiries, but must do so through the post. You can easily understand that the inquiries made by you are not of general interest to our readers, and our space is so inadequate that we cannot afford to devote it to subjects from which no practical benefit to our readers is likely to result.

H. L. O. (Lambeth.)—It is by no means impossible to construct such a vessel, and the power named (700) being understood to be nominal H.P., the speed of 12 knots might be obtained.

J. (Liverpool.)—The screw of the *Leviathan* is to be worked by an auxiliary engine, erected for that purpose, and the speed will be about the same as the paddle-wheels, so as to prevent drag.

Other correspondents must excuse us replying until next month.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 1st December, 1857.

2982. J. Young, Glasgow—Measuring liquids.

Dated 6th February, 1858.

221. T. Waraksine, Russia — Specific corn sorting machine.

Dated 7th February, 1858.

24. J. Kidd, 6, Bridge-parade, Bristol—Apparatus for regulating the pressure and supply of steam, gas, or other rarified or compressed bodies, and for causing more perfect combustion of the gases procured from coal, and increasing the heating and illuminating power of the said gases.

Dated 9th February, 1858.

240. R. Millard, Duncannon-st., Trafalgar-sq.—A portable chair.

Dated 11th February, 1858.

259. C. Johnson, Dickleborough, Norfolk, and G. Johnson, Wandsworth—Apparatus for performing different operations required in agriculture

Dated 13th February, 1858.

275. J. Duncan, Greenock—Ornamental chenille fabrics.

Dated 16th February, 1858.

292. R. Anderson and J. J. Prescott, Duke-st., Liverpool—Lubricators.

Dated 18th February, 1858.

306. J. Piddington, 77, Montagne de la Cour, Brussels—Fuel, commonly called artificial or patent fuel.

Dated 20th February, 1858.

328. T. Metcalf, Newton Heath, Manchester—Purification of crude tar oil, rendering the same suitable for lubricating machinery and other similar purposes.

338. J. Sworn, 29, Churton-st., and T. Weston, 40, Churton-st., Pimlico—Composition for whitening and clearing the surface of stones.

Dated 25th February, 1858.

378. S. Middleton, 5, Little New-street, Fetter-lane—Seaming articles of leather.

Dated 27th February, 1858.

390. D. Nurse, R. Nurse, and G. Nurse, Machan, South Wales—Coating metals.

Dated 1st March, 1858.

398. T. Mills, Patrick, Lanark, N.B.—Apparatus for treating and dressing flour or reduced grain.

Dated 3rd March, 1858.

416. W. H. Sleeboom, Hamburgh—Construction of the keel of ships or other vessels.

418. G. and J. Kirkley, Salford — Perforating slates or similar materials.

420. J. Gowing, Poplar, and H. Bull, Greenwich—Apparatus for preventing smoke, applicable to tubular boilers.

424. J. Fowler, jun., Cornhill—Laying down electric telegraph cables.

Dated 4th March, 1858.

426. C. Hart, P. Gibbons, and H. Gibbons, Wantage, Berkshire—Combined thrashing and winnowing machines.

427. J. M. Ure, Glasgow—Lifting the driving wheels of a locomotive off the rails, and when the locomotive is either running or stationary.

428. G. F. Hipkins, Birmingham — Attaching knobs and spindles.

429. J. Knowelden, Southwark—Obtaining motive power.

431. J. Dewar, Edinburgh—Manufacture of boots and other coverings for the feet.

432. C. P. Stewart, and D. G. Hope, Manchester—Locomotive and other engines.

433. S. Boulton, 11, Luther-street, Everton, near Liverpool—Obtaining certain products from materials used in the manufacture or purification of gas.

434. P. Moore, Birmingham—Manufacture of hinges.

435. T. Cowper, Douglas, Isle of Man — Construction of ships or vessels, and discharging bilge water therefrom.

437. W. Thomson, Glasgow—Apparatus for applying and measuring resistance to the motion of rotating wheel shafts or other rotating bodies.
Dated 5th March, 1858.
438. C. Boyce, Tipton—Anchor.
439. H. G. Collins, Paternoster-row—Obtaining impressions on an enlarged or diminished scale from engraved plates or other printing surfaces.
440. A. G. Barham, Bridgewater—Manufacture of gypsum.
441. C. F. Vasserot, 45, Essex-st., Strand—Manufacture of wrought iron wheels for locomotives, tenders, and waggons, &c.
442. N. Common, Rose-hill, Brighton — Arrangement of water supply valve.
443. J. F. Cole, Devonshire-st.—Watches and time-keepers, and an improved escapement wheel or pallet to be employed therein.
444. J. N. Hearder, Plymouth—Submarine telegraph cables.
445. C. F. Parsons, Duke-st., Middlesex—Machinery for revivifying animal charcoal.
446. J. H. Johnson, 47, Lincoln's-inn-flds.—Railway signals.
Dated 6th March, 1858.
447. C. R. Moate, 65, Old Broad-st.— Permanent way of railways.
448. G. Davies, 1, Serle-street, Lincoln's-inn—A substitute for red lead, either as a cement for joints or a coating for preserving metals.
449. S. Wheatcroft, 14, Brudenell-pl., Hoxton—Manufacture of cap fronts, and applicable to ruches and ribbon trimmings.
450. R. S. Bartleet, Redditch, Worcester—Papers, envelopes, and cases for holding needles.
451. J. S. Nibbs and J. Hincks, Birmingham—Oils and spirit lamps.
452. Comte C. Cavalli de St. Germain, Piedmont—Starch.
453. W. Wilkinson, Bayswater—Facilitating communication across seas or other waters, parts of which are applicable to telegraphing on land.
454. R. A. Brooman, 166, Fleet-street—Skirts and petticoats.
455. E. Burke, 69, Upper Thames-st.—Applying iron tubes to locomotive and other tubular steam boilers.
456. A. Whytock, 12, Little St. Andrew-street, Upper St. Martin's-lane—Apparatus to be applied to wheels to facilitate them in travelling on common roads and other surfaces.
457. W. Reid, 58, Westgate st., Newcastle-on-Tyne—Permanent way of railways.
458. J. W. Clare, Surrey-square — Stopping or retarding railway engines, carriages, and trains, and communicating signals between parts of a train.
459. A. S. M. Derouen, Paris—Combing fibrous substances.
461. J. H. Johnson, 47, Lincoln's-inn-fields — Production of aluminium and its alloys, and in the production of other metals the oxides of which are not reducible by charcoal.
462. C. Sanderson, Sheffield—Malleable iron and steel.
463. E. Morel, Ghent, Belgium—Machinery for drawing fibrous substances.
464. J. H. M. Maissiat, Paris—Dibbling machinery for depositing grain and manure.
Dated 8th March, 1858.
465. G. Redford, 6, Hutton-st., Moss Side, Manchester—Making bullet cartridges of one piece of metal.
467. T. Lyne, Malmsbury, Wilts—Harrow.
468. J. H. Johnson, 47, Lincoln's-inn-fields— Ornamentation of leather, cloth, and similar fabrics, and the application of the same to various useful purposes.
469. J. Young, Wolverhampton—Hinges.
470. H. Doulton, Lambeth—Smoke and air flues.
471. J. P. Budd, Ystalyfera Iron Works, Swansea—Smelting of tin, tin ores, and tin scruff.
472. W. Clark, 53, Chancery-lane—Gas meters.
Dated 9th March, 1858.
473. M. Casentini, Westminster-road, Lambeth—Indurating plaster, in preparing surfaces to receive plaster, and in preparing or perfecting plaster surfaces.
474. J. E. Poynter, Glasgow—Illuminating oil.
475. R. Skene, Garmouth, Fochabers, Elgin, N.B.—Motive power from water.
477. G. F. Harrington, Ednam House, Ryde, Isle of Wight —Artificial teeth, and in the beds and palates for teeth.
478. F. C. Warlich, Hope cottage, Gloucester-pl., Kentish-town—Generating steam.
479. J. H. Johnson, 47, Lincoln's-inn-fields—Stockings and other hosiery goods.
480. G. T. Peppé, 68, Britannia-terrace, City-road, and Louis Goodman, 285, Oxford-street—Construction and arrangement of timekeepers.
Dated 10th March, 1858.
481. G. Davies, 1, Serle-st., Lincoln's-inn—Eye or ring bolt.
482. H. Dauphin, Nantes—Machine for giving to metallic bands a circular or partly circular form.
483. B. Beale, East Greenwich—Cutting and shaping spokes.
484. W. Harding, 1, Park-villas, Forest-hill—Breech-loading fire-arms.
485. G. S. Andrews, Charlewood-street, Pimlico—Washing machines.
Dated 11th March, 1858.
487. G. Davies, 1, Serle-st., Lincoln's-inn—Life boats.
488. R. Roberts, Manchester—Mechanism for engraving, and otherwise copying in line, paintings and other designs on flat and curved surfaces of metal, paper, and other materials.
489. J. Young, Glasgow—Lamps.

490. A. J. Holdsworth, Leeds—Railway oral communication.
491. J. D. Humphreys, Charlotte-st., Middlesex—Machinery for moulding, compressing, and solidifying artificial fuel and other substances capable of being compressed.
492. G. T. Bousfield, Loughborough-park, Brixton—Knitting machines.
493. F. A. Verdeil, Rue St. Sulpice, Paris—Madder.
494. J. D. Leathart, Newcastle-on-Tyne—Furnaces.
Dated 12th March, 1858.
496. A. Porecky, 7, York-st. north, Hackney-rd.—Frames of umbrellas and parasols.
497. J. Worrall, Salford, and C. Race, Manchester—Apparatus for stretching and drying fabrics, part or parts of which said apparatus are also applicable to other machines wherein fabrics are required to be distended.
498. M. Smith, Heywood, Lancashire—Looms for weaving.
499. J. Warburton, Low mills, Addingham, near Otley—Carding engines.
500. T. Thompson, Radbourne, Derby—Vats for cheese making.
501. T. T. Chellingworth, Birmingham—Suspending chandeliers and gas pendants.
502. W. Pearson, Brierly-hill, Staffordshire — Improved washing machine.
503. A. Ash, Woolwich—Pocket or other like safety clasp or protector.
504. J. Wright, 10, Alfred-place, Newington-causeway, Southwark—Treatment of machine-made malleable iron nails.
505. J. Wright, 10, Alfred-place, Newington-causeway—Southwark—Treating tanned and untanned hides and leather.
506. A. V. Newton, 66, Chancery-lane—Instruments for extracting teeth.
507. L. F. Corbelli, Florence—Extracting aluminium from its compounds, and obtaining at the same time protochloride of mercury.
508. J. T. Coupier, Paris—Treating vegetable fibrous matters. to render them applicable for the manufacture of paper and pasteboard, and in apparatus connected therewith.
Dated 13th March, 1858.
509. G. Carter, Mottingham, Kent—Steam engines and machinery for propelling vessels.
510. C. Tilliere, Brussels—Machinery for forging, planing, and stamping cold or heated metals.
511. S. T. Parmelee, Edinburgh—Combining certain materials to be used in the manufacture of boots and shoes.
512. G. Pigott, Nottingham—Machinery for figuring lace and other fabrics.
513. S. Walker, Birmingham—Tubes of copper and alloys of copper.
514. J. Jameson, 10, Catherine-terrace, Gateshead—Apparatus for compressing and expanding aëriform fluids.
515. W. Riddle, 4, Stonefield-terrace, Liverpool-road — Wrought-iron nails.
516. A. V. Newton, 66, Chancery-lane—Horse shoes.
517. S. T. Osmond, Ramsbury, Wiltshire, and E. D. Collins, Newbury—Ploughs.
Dated 15th March, 1858.
518. J. C. Martin, Fern cottage, Charlewood-road, Putney—Plastic compound for the manufacture of moulded articles.
519. J. D. Briet, Paris—Pipes for smoking.
520. R. Edwards, 1, Single-street, Canal-road, Mile-end-road—Preparing and combining materials used in lighting or kindling fires.
521. J. Gough, Chester—Horse-gear for driving machinery.
522. R. A. Brooman, 166, Fleet-st.—Sewing machines.
523. L. J. Tellier, Pithiviers—Machinery for raising water and other liquids.
525. A. Ferry— Cornets and other wind musical instruments.
526. J. Aked and J. Crabtree, Halifax—Apparatus for warping and beaming yarns for weaving.
527. J. S. Russell, Great George-street, Westminster—Preserving the bottoms of iron ships and vessels.
528. J. Hamilton, jun., Liverpool—Apparatus for propelling vessels.
529. A. Wallis and C. Haslam, Basingstoke — Engine, machine, and other like bearings.
530. J. F. Empson, jun., Birmingham—Ornamenting certain kinds of buttons.
531. E. A. L. D'Argy, Batignolles, near Paris—Rotary hydraulic blowing engine.
Dated 16th March, 1858.
532. D. Gallafent, Stepney-causeway—Apparatus for cooling liquids and condensing vapours.
533. G. Hall, St. John's, Worcester—Cartridges and gun wads
534. M. Henry, 77, Fleet-street—Production of artificial marble, frescoes, and decorative, ornamental, and artistic surfaces, objects, and works.
535. W. T. Eley, Broad-street, Golden-square—Cartridges.
536. J. Lawson, Hope Foundry, Leeds—Machinery used in spinning flax and other fibrous substances.
537. P. Le Capelain, Blackfriars-road—Dry gas meters.
Dated 17th March, 1858.
538. W. S. Clark, Atlas Works, Upper Park-pl., Dorset-sq. —Machines for cutting and harvesting grain and grass crops.
539. C. F. Vasserot, 45, Essex-st., Strand — Treatment of horn, and in the application as a substitute for whalebone.

540. D. Nicoll, 114, Regent-st.—Machinery for cutting out military, naval, and other clothing.
541. W. Todd and J. Todd, Heywood, Lancashire—Power looms for weaving, and in shuttles to be employed therein.
543. J. Gooderham, John's-cottage, Mathias-st., Kingsland —Shoemakers' wax.
544. W. C. Beatson, Masbro', Yorkshire– Apparatus to be used in the manufacture of glass bottles.
545. T. C. Hine, Nottingham—Lighting and ventilating by gas.
546. T. Evans, Hanover-st., River-ter., Islington—Manufacture of parasols.
547. R. A. Brooman, 166, Fleet-st.—Boxes or cases for trees, flowers, and other horticultural and floricultural purposes.
548. W. Ward, Smethwick—Machinery for the manufacture of nails, spikes, bolts, rivets, screw blanks, and nuts.
549. J. Oxley, Beverley, Yorkshire—Fitting piece for windows, blinds, shutters, and doors, which is also applicable for other purposes.
Dated 18th March, 1858.
550. L. E. Fletcher, Upper Norwood—Marine engines and boilers.
551. R. Glanville, Bermondsey—Condensing steam engines.
552. C. Doley, Birmingham, E. Bigland and T. H. Worrall, Smethwick—Ornamenting metals.
553. J. Webster, Birmingham—New metallic alloys.
554. Sir J. C. Anderson, Bart., Fermoy—Locomotive and other carriages.
555. A. Dunlop and A. Stark, Moor Park Mill, Renfrew, N.B.—Sifting flour and meal or reduced grain.
556. T. Suffield, Bermondsey—Pumps, especially adapted for ships' purposes.
557. R. A. Brooman, 166, Fleet-st.—Knee cap.
558. T. S. Sutton, Glynleiros, Neath, Glamorganshire—Miners' lamps.
559. R. Townend and W. Townend, Bradford—Piston-valve musical instruments.
560. A. V. Newton, 66, Chancery-lane—Process of polishing, blueing, and annealing articles of iron and steel.
561. A. A. Croll, Coleman-street—Manufacture of parts of dry gas meters.
562. J. A. J. Redier, Paris— Chronoscope.
Dated 19th March, 1858.
563. P. F. Aerts, Brussels—Railway rolling stock. and lubrication thereof.
564. H. Brocklebank, Coventry — Chronometers, watches, and timekeepers.
565. G. Scott, Manchester—Generating elastic fluids, and in apparatus.
566. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Motive power.
567. W. H. Rhodes, Oldham—Speed indicators and calculators.
568. G. Williams and E. Rowley, West Bromwich—Piling iron.
569. T. C. Medwin, 10, Clayton-pl., Kennington-rd.—Water gauges for steam boilers.
570. J. M. May, Lambeth-hill—Fastenings for portmonnaies, &c.
571. D. Evans, 15, Railway-terrace, New-town, Stratford—Supplying air in streams to furnaces.
572. G. F. Muntz, Frenchwalls, near Birmingham—Mixing zinc with copper and other metals.
573. J. Young, Knaresboro'—Chronometers, clocks, and watches.
574. J. Bramwell, Buxton, Derbyshire—Apparatus for the prevention of accidents arising from the escape of gas.
Dated 20th March, 1858.
575. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Piercing of tunnels.
576. W. Haigh, Reddish, Lancashire—Manufacture of a certain description of paper, and in the machinery connected therewith.
578. P. M. Parsons, Duke-street, Adelphi, and W. Dempsey, Great George-street, Westminster — Switches and crossings for railways.
579. L. Cowell, Adelphi—Apparatus for teaching the art of swimming.
580. J. Brooks, Elton, near Bury — Drawing frames for fibrous materials.
581. R. Mills, Bury—Washing machines.
582. P. Browne, Liverpool—Screw propeller, partly applicable to the raising of fluids.
583. J. Biggs and W. Biggs, Leicester—Polkas when looped or elastic fabrics are used.
584. W. Allen, Arthur-street, Coventry-road, Birmingham—Machinery for manufacturing screws.
585. J. Le Franc, 58, Aldersgate-st.—Pressure gauges.
586. A. V. Newton, 66, Chancery-lane—Sewing machines.
587. W. E. Newton, 66, Chancery-lane—Treating and combining various combustible matters or substances for the production of artificial fuel.
588. J. T. Pitman, 67, Gracechurch-st.—Soap and apparatus.
589. J. T. Pitman, 67, Gracechurch-st. — Preparing and moulding clay, &c.
Dated 22nd March, 1858.
590. R. A. Brooman, 166, Fleet-street—Apparatus for exhibiting daguerreotype, photographic, and other stereoscopic views and pictures.
591. E. J. Manwaring, Lee, Kent—Stereoscopic apparatus.
592. J. Thomas, Hackney—Machinery for counting, and registering or paging.
593. C. C. Bailey, Manchester—Supplying the feed water to boilers.

594. G. Davies, 1, Serle-st., Lincoln's-inn—Metallization of objects for the electrotype or galvanoplastic process.
595. J. Juckes, Dame-street, Wharf-road, City-road, Islington—Apparatus for supplying coals to stoves and fireplaces.
597. I. Holden, St. Denis, and E. Hubner, Mulhouse, France—Preparing, heckling, or combing flax, silk, wool, and other fibres.
598. J. Wright, 10, Alfred-place, Newington causeway—Punching rolled metal plates and angle iron.
599. H. A. Jowett, Sawley, Derbyshire — Machinery for transmitting telegraphic communications.

Dated 23rd March, 1858.

600. H. L. Muller, Paris—Chromographic printing.
601. C. Atherton, H.M. Dockyard, Woolwich—Furnaces, fire grates, and stoves.
602. A. S. Stocker, 18, Wimpole-street, Cavendish-square — Railway axles and tubes.
603. W. Mould, Bolton—Machinery for preparing and spinning fibrous materials.
604. J. Rowbottom and T. Standeven, Halifax—Washing, wringing, and mangling machines.
605. W. E. Wiley, 34, Great Hampton-street, Birmingham—Ever-pointed pencils.
606. C. Clifford, Inner Temple-lane—Ships' davits, and in apparatus for stowing, lowering, and securing boats.
607. E. Coulon, Croisset, near Rouen, France—Preventing the incrustation of steam boilers.
609. W. S. Keith, York-street, Southwark—Rotary cutting machine.
610. C. F. Quintin, Cheltenham—Kneading machine.
611. W. Ramsell, Deptford—Furnaces and fireplaces.

Dated 24th March, 1858.

612. J. C. Wilson, 11, Soley-terrace, Pentonville—Introducing elastic substances into articles of wearing apparel.
613. R. Jackson, Calder-vale, Garstang — Machinery for spinning fibrous substances.
614. H. Gerner, 10, Newton-road, Bayswater—Apparatus for the manufacture of gas from oils or fatty or resinous matters.
615. C. Chevallier, M. I. Olivier, and E. Rolland, Brussels—Machine for making and applying, as soles to shoes and boots, gutta percha and caoutchouc.
616. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Construction of heating apparatus.
619. C. N. Kottula, Liverpool—Manufacture of neutral hand or skin soap.
620. A. Biddell and W. Balk, Ipswich—Steam boilers.
621. J. F. Brinjes, jun., 25, Fieldgate-street, Whitechapel, and H. J. Collins, West-hill, Wandsworth—Manufacture and reburning of animal charcoal.
622. W. Wood and R. Wood, Radcliffe, Lancashire—Machinery for spinning, doubling, and sizing yarns or threads.
623. J. V. Hielakker, Brussels—Machine for compressing coal, other fuel and substances.

Dated 25th March, 1858.

625. W. S. Clark, Atlas works, Upper Park-place, Dorset-square—Railways.
626. D. A. Hopkins, Paterson, U.S.—Journal boxes.
627. W. Crook, Blackburn—Looms.
628. J. Nuttall, Walmersley, near Bury—Looms.
629. G. H. Ellis, New Malton, Yorkshire—Kitchen ranges.
630. W. E. Newton, 66, Chancery-lane—Lamps for burning certain kinds of oil and hydro-carbons.
631. F. Haeck, 14, Place de la Reine, Brussels—Pumps for pumping beer, or other liquids, containing acids or oily matters.
632. F. Foucou, 44, Rue Caumartin, Paris—Steam boiler and other furnaces.
633. W. Richards, Birmingham—Breech-loading guns and fire-arms.
634. J. Young, Knaresbro'—Signalling on railways.
635. W. Robjohn, Stanhope-street, Hampstead-rd.—Organs.
636. F. A. Chevallier, Paris—Photographic apparatus.

Dated 26th March, 1858.

637. R. A. Brooman, 166, Fleet-street—Weighing machines.
638. W. Moxon, J. Clayton, and S. Fearnley, Bluepits, Lancashire—Machinery for paying out electric telegraph cables, ropes, &c.
639. P. H. G. Bérard, 323, Rue St. Denis, Paris—Applying concentrated collodion to the effect of superseding caoutchouc in waterproofing stuffs of all descriptions for manufacturing garments.
640. J. Parkes, Birmingham—Eyelets.
641. J. Horton, Smethwick—The construction of the girders used in the guide framing of gasholders.
642. R. M. Butt, Fairfield Works, Bow—Night lights.
643. H. Doulton, Lambeth—Manufacture of invert blocks.
645. W. E. Newton, 66, Chancery-lane—Machine for performing the addition of numbers—The "arithmometer."

Dated 27th March, 1858.

646. V. F. Jeanne and E. M. G. Martin, Paris—A machine for breaking stones.
647. J. Newman and J. F. Newman, 122, Regent-street—Spectacles.
649. E. C. Jones, Caroline-st. Bedford-sq.—Railway brakes.
650. J. Bushell and T. Wright, Manchester—Grids for covering openings, through which fuel is deposited, in vaults or cellars, self-securing.
651. B. Burrows, Leicester—Weaving webs or narrow goods.
652. W. W. Eley, Broad-street, Golden-square—Cartridges.
653. J. Welch, Southall—Portable railways.
654. J. A. V. Burq, Paris—Weighing machines.
655. W. A. Gilbee, 4, South-street, Finsbury—Treating saccharine fluids.

Dated 29th March, 1858.

657. W. A. Gilbee, 4, South-street, Finsbury — Treating brandies and other spirituous liquids, for improving their quality.
658. W. Garnett and C. Geldard, Low Moor, near Clitheroe, and J. Dugdale, Blackburn, Lancashire—Looms for weaving.
659. J. R. Breckon, Darlington, and R. Dixon, Crook, Durham—Coke ovens.
660. W. Chadwick, Bury—Hoods or tops, and in the footsteps and bearings of ventilators.
661. J. F. Spencer, 1, Adelaide-place, London-bridge — Marine engines.
662. J. Horton, Smethwick, Staffordshire—Machinery to be employed in punching metals.
663. J. Baillie, 167, Carolinen Gasse, Vienna — Coiled spring.
664. J. C. Durand, Pimlico—Chain cables.
665. I. Brown, Carlisle, and J. Brown, Notting-hill—Manufacture of manure.
666. G. Paterson, Glasgow — Apparatus for effecting the combustion of fuel and the consumption or prevention of smoke, applicable to boiler furnaces.
667. E. A. Jacquin, Rue des Lavandieres, Ste. Opportune, Paris—Preparing plates for printing.
668. W. Davis, 11, George-street, Chick's-buildings, and T. Harper, Brewery-house, Broadplaines, St. Phillip's, Bristol—Apparatus for cutting soap.
669. W. Harding, Forest-hill, Kent—Revolver fire-arms.

Dated 30th March, 1858.

670. F. Robinson and E. Cottam, Pimlico—Hydrostatic and other presses.
671. J. C. Durand, Pimlico—Manufacture of iron.
672. W. Weallens, 12, Elswick-villas, Newcastle-upon-Tyne—Parabolic governors, and applying the same to steam engines.
673. T. Silver, Philadelphia, U.S. — Pulsating valves or governors.
674. T. Steven, T. Reid, and T. Frew, Glasgow—Moulds for casting.
675. B. Wood, Huddersfield—Machinery for cleansing the waste of fibrous manufactures.
676. W. G. Whitehead, Birmingham—Waterproof paper.
677. W. E. Newton, 66, Chancery-lane—Manufacture of sheet iron.
678. W. Oldfield, Skipton, and T. O. Dixon, Steeton, Yorkshire—Gas burners.

Dated 31st March, 1858.

679. F. A. Gatty, Accrington—Treating certain compounds containing the colouring matter of madder.
680. J. Musgrave, jun., Globe Iron Works, Bolton-le-Moors—Application of the heat from the furnaces of singeing or dressing plates to generating steam and drying purposes, and improvement in the construction of such furnaces.
681. M. B. Westhead and H. Baines, Manchester—Apparatus for coupling or connecting carriages, wagons, trucks, vans, and engines.
682. J. W. Duce, Wolverhampton—Locks and latches, and in attaching knobs to lock and latch spindles.
683. E. H. Todé, Peckham—Apparatus for generating steam in steam boilers by means of gas.
684. J. H. Whitehead, Royal George Mills, Saddleworth, Yorkshire—Woollen bags.
685. B. W. Croker, Vienna—Axle boxes to render them self-lubricating.
686. J. Mercer, Cambridge, U.S.—Manufacture of leather.
687. F. Edwards, Hillfields, and W. Edwards, Howard-street, Coventry—Weaving.
688. H. Napier, Hyde-road, Ardwick, Manchester—Production of volatile oil of resin.
689. J. H. Johnson, 47, Lincoln's-inn-fields — Articles of buoyancy, to be used either for swimming or for the saving of life from drowning.
690. R. Peter, Dundee—Gill machinery for manufacture of textile materials.
691. R. Barr, Glasgow—Machinery or apparatus for making rivets, spikes, nails, and screw blanks.

Dated 1st April, 1858.

692. A. Pelez, 9A, Mortimer-street, Cavendish-square—Hydraulic machines.
693. E. A. Colette, Dieppedalle, near Rouen, France — Hashing meat with a mechanical chopping-board.
694. A. P. Dadley, New Hall-street, and N. Brough, Birmingham—Buckle or metallic adjuster for adjusting braces, belts, garters, and such like articles of dress.
695. F. R. Tavernier and J. A. F. Tavernier, 213, Rue St. Dominique, St. Germain, Paris — Machinery for combing fibrous materials.
696. F. J. E. Oosterlinck, Paris—Valve or plug.
697. H. Ward, Hamburg—Machinery for expressing liquids from organic substances.
698. W. E. Newton, 66, Chancery-lane — Machinery for manufacturing corks.
699. H. Bentley, Horton, near Bradford—Machinery employed in preparing and spinning fibrous substances.
700. T. Boardman, Pendleton, and J. Allcock, Stockport—Looms.
701. C. G. Russell, Manchester—Machinery for printing.
702. T. F. Robinson, Halifax—Apparatus for cutting cork.

Dated 3rd April, 1858.

703. T. Greenshields, 11, Little Titchfield-street—Treating ammoniacal liquor produced from coal in making gas, and obtaining useful products for making artificial manure.
705. V. Gache, sen., Nantes, France—Steam engines for the use of vessels.
706. A. Pelez, 9A, Mortimer-street, Cavendish-square — Steam piston.
708. J. H. Johnson, 47, Lincoln's-inn-fields—Ships' propellers.
709. C. Tress, Blackfriars-road — Hats made from palm-leaf, grass, chip, Tuscan, Leghorn, Panama straw and other like materials.
710. J. Fowler, jun., 28, Cornhill— Apparatus used when ploughing, tilling, or cultivating land by steam power.
711. W. Crowley, Newport Pagnell—Combining and working ploughs.
712. D. Morrison, Birmingham—Boiling oils.
713. H. Cartwright, Dean, Broseley, Shropshire — Construction of eccentrics, and in the mode of working them when applied to steam engines.
715. S. Minton and R. H. Thomas, Clough Hall Collieries, Staffordshire—Battery.
716. R. Targett, Windmill-street, Finsbury—Applicable to lamp glasses or shades.
717. A. V. Newton, 66, Chancery-lane—Machinery for cutting veneers.
718. J. Stobbs, Sydney-street, and G. R. Hall, Linskill-street, North Shields—Pumps for raising water and other liquids.

Dated 5th April, 1858.

719. W. Clark, 53, Chancery-lane—Water tank for ships and other vessels, and mode of applying the same on board a vessel, whereby it is capable of conversion into a float for saving life and property in case of the foundering of the vessel.
721. J. C. Dieulafait, 2, Rue Sainte-Appoline, Paris—Method of manufacturing garments, whereby one garment may be changed in form to that of several others.
723. R. C. H. Groombridge and H. Groombridge, 5, Paternoster-row, and J. Musselwhite, 19, Aldersgate-street — Black-board and apparatus for teaching music.
725. O. Sarony, Scarborough—Photographic portraits.

Dated 6th April, 1858.

727. W. B. Webster, Adam-street—Making of butter.
729. E. Owen, Blackheath—Artificial fuel, and in the application of the same to metallurgical purposes.
731. R. Hornsby, jun., Spittlegate Works, Grantham — Ploughs.
733. H. Schwietzer, J. Holder, and J. Broughton, Scarp Castle, Brighton—Concentrating and retaining the valuable properties of farmyard and stable manure.
735. D. Davy, W. Bentley, and J. Davy, Bradford—Looms employed for weaving.
737. J. Sangster, Newington— Glazing in wood without putty.
739. R. H. Collyer, Marylebone—Manufacture of paper.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

577. D. Harris, Massachusetts, U.S.—Sewing machines.—20th March, 1858.
648. R. Williams, 8, Bishop's-rd., Victoria-park — Manufacturing a soap for cleansing, bleaching, and purifying purposes.—27th March, 1858.
749. E. Foster, Connecticut, U.S.—A new and useful or improved life-preserving berth for navigable vessels.—7th April, 1858.
752. S. O. Mason, Connecticut, U.S.—Certain new and useful improvements in door hinges. (A com.)—8th April, 1858.
753. E. Richmond, Massachusetts, U.S.—Certain new and useful mechanism for reducing, or reducing and crushing, and in various other respects treating grain, sugar cane, tobacco, or other substance or substances. (Partly a com.)—8th April, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

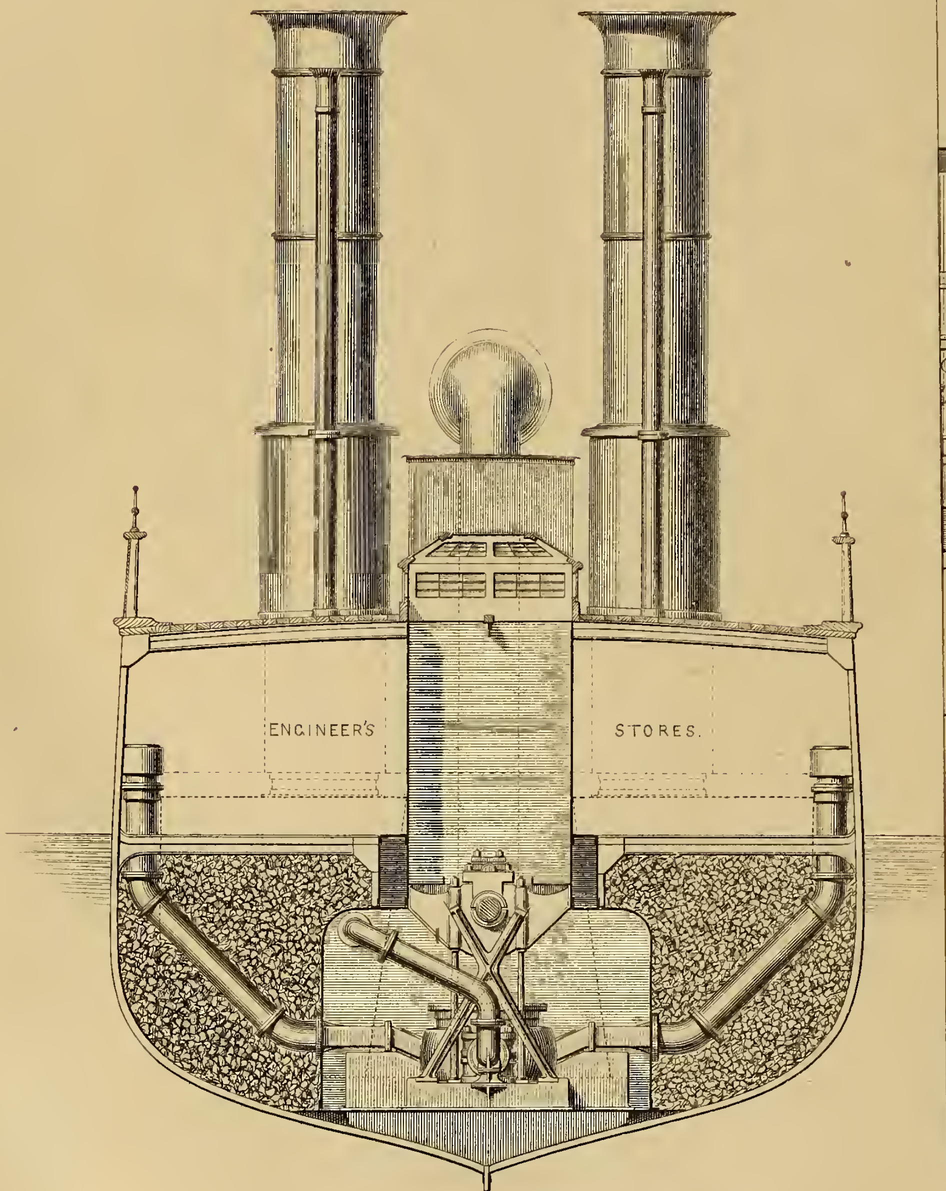
4067.	March	17.	T. Pemberton and Sons, Birmingham, "Catch or fastening for cupboard and other Doors."
4068.	,,	19.	H. Thompson, 302, Strand, "Certain parts of Folding Bedsteads or Chairs."
4069	,,	25.	Griffiths and Hughes, Birmingham, "Improved Solid Rule Joint."
4070.	,,	25.	A. Smart and J. Howland, Fenchurch-st., City, "The Smoker's Sweetheart."
4071.	,,	26.	Rev. A. W. Noel, Cropredy, Oxon, "Reading Stand."
4072.	,,	27.	W. Wilson, King-st., Manchester, "Prismatic Reflector for Ceiling Gas Lights."
4073.	April	6.	M. Lyons, Suffolk, Birmingham, "Tag or Fastener."
4074.	,,	8.	W. Herring, 121, St. John-street, West Smithfield, "Improved Curved Tooth-Brush."
4075.	,,	9.	W. W. Rouch, 180, Strand, "Photographic Portable Dark Operating Chamber."
4076.	,,	9.	H. Bridson, Bolton-le-Moors, Lancashire, and C. C. Pole, Temple, London, "A Marine Course and Distance Indicator."
4077.	,,	12.	A. Turley, New-street, Worcester, "A Combined Needle Case."
4078.	,,	17.	T. Truss, Chester, "Improved Roof Lamp."
4079.	,,	20.	W. M. Staunton, Birkenhead, Cheshire, "Improved Spring Mattress for ensuring Purity of Air and Ventilation."

ENGINES OF SCREW STEAM SHI

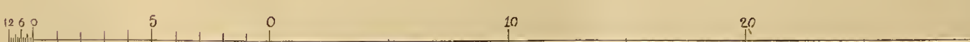
SCAMANDER, MEANDER AND ARAXES.

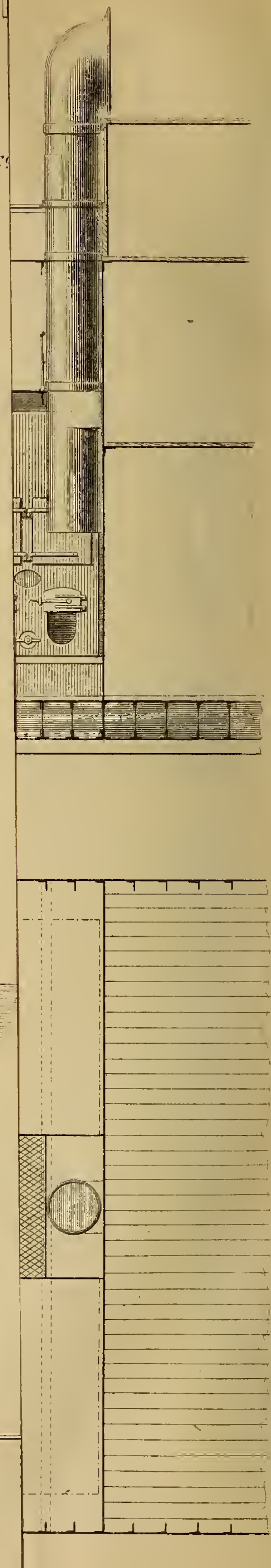
CONSTRUCTED BY MESSRS. SLAUGHTER, GRUNING & Co.

AVONSIDE IRON WORKS, BRISTOL.



TRANSVERSE SECTION.





THE ARTIZAN.

No. CLXXXV.—Vol. XVI.—JUNE 1st, 1858.

ENGINES OF SCREW STEAM SHIPS "SCAMANDER," "MEANDER," AND "ARAXES."

CONSTRUCTED BY MESSRS. SLAUGHTER, GRUNING AND CO., AVONSIDE IRON WORKS, BRISTOL.

Illustrated by Plate No. cxxiv.

We have at every convenient opportunity illustrated what appeared to us to be the best examples of screw engines, more particularly those suited for mercantile purposes; and we now present our subscribers with a large Plate, containing three views of some highly creditable specimens of marine steam engineering, designed and constructed by Messrs. Slaughter, Gruning and Co., of Bristol. The engines, boilers, &c., of the three sister ships which we have selected for illustration, in addition to the peculiarities which they present, possess not only considerable constructive merit, but also all those qualities which recommend them to the owners of steam ships, and the results of the continued working of these three steam ships and their machinery during an average period of three years are considered to be highly satisfactory.

The ships, as well as their machinery, were constructed by Messrs. Slaughter and Co.; they have applied the screw shaft at an angle, instead of placing the shaft horizontally, as usual, and consider that to this arrangement may be attributed the small amount of wear and tear on the thrust collars and other parts, the absence of undue straining and damage to the cranks and adjacent parts of the engine, and therefore the highly satisfactory working of the engines and machinery.

The principal dimensions of the "Araxes" are as follows:—

Length between perpendiculars	250 ft.
Beam	32 ,,
Depth from top of floors to underside deck	21 ,,
Tonnage (builders' measurement)	1260 tons.

She has 18 ft. of dead flat, and is a very burdensome ship. She left Liverpool with 900 tons of coal and 600 tons of cargo.

As to model, the ships are considered to be excellent specimens of iron vessels for cargo carrying, and as to construction they are believed to be equal to anything afloat.

The following are the particulars of the

ENGINES OF THE "SCAMANDER," "MEANDER," AND "ARAXES."

Principal Dimensions.

	Ft.	In.		Ft.	In.
Diameter of cylinders	0	50	Diameter of screw shaft	0	10
Stroke ,,	3	0	Diameter of screw	14	0
Diameter of air-pump	0	30	Pitch	30	0
Stroke	0	18	Number of blades	3	
Diameter of engine shaft	0	11	Length fore and aft	3	5

BOILERS.

Tubular. Two in number. Six Furnaces in each Boiler.

Diameter of tubes	0	$3\frac{1}{2}$
Length ,,	6	6
Number of tubes in each boiler	324	
Area through tubes	2,689 sq. in.	
Diameter of chimney	4	6
Width of furnaces	2	9
Length of furnaces	5	6
Area of fire-bar for one boiler	90·75 sq. ft.	
Tubular surface	3,855 ,,	
Flue ,,	900 ,,	
Total ,,	4,755 ,,	
,, per H.P	19 ,,	
,, fire-bar surface	·726 ,,	

RATIOS.

Ratio of heating surface to fire-bar	26·2 to 1
,, fire-bar surface to area through tubes	4·86 to 1
,, area through tubes to area of chimney	1 to 1·18

This thrust bearing in the *Araxes, Scamander*, and *Meander*, is of precisely similar construction to that in the *Himalaya*, consisting of seven collars, with an aggregate surface of 365 sq. in., pressing against hard gun metal. And in no one of these boats has the metal worn 1-32 of an in., although one of them has been running constantly for more than three years. The time and distance these boats have run are as follows:—

	"SCAMANDER."	"MEANDER."	"ARAXES."
Time	3 Years 2 Months.	2 Yrs. 10 Mo.	2 Yrs. 2 Mo.
Distance in Nautical Miles	95,000 miles.	85,000 miles.	65,000 miles.

The very small amount of wear and tear on the thrust blocks, and the general good performance of the machinery, are attributed to the fact that, when the ship is in her ordinary trim, about 2 ft. by the stern, the screw shaft has the inclination of 7 per cent.; the thrust of the screw, consequently, has to overcome the weight of the propeller and shafting, about 12 tons, gravitating down this incline, before it throws any strain whatever on the thrust bearing.

On reference to the log, it will be perceived throughout that the vacuum is bad; they state, however, that they can maintain easily 27 in. in all their boats; but it is found most *economical* to work with a hot well of the temperature of about 120° Fahr.

The extracts from the log book of the *Araxes*, and the copies of the indicator diagrams, taken from the engines of the *Meander, Araxes*, and *Scamander*, which accompany the log extracts we have made, will be given in our next Number, and will enable our readers to judge of the performances of the three vessels, as they each tell their own story.

AN INQUIRY INTO THE STRENGTH OF BEAMS AND GIRDERS OF ALL DESCRIPTIONS, FROM THE MOST SIMPLE AND ELEMENTARY FORMS, UP TO THE COMPLEX ARRANGEMENTS WHICH OBTAIN IN GIRDER BRIDGES OF WROUGHT AND CAST IRON.

By Samuel Hughes, C.E., F.G.S., &c.

(Continued from page 84.)

Further Examination of Mr. Fairbairn's Experiments on Flanged Cast-Iron Beams.

I have given, at page 174 of The Artizan for 1857, a short Table showing the coefficients for flanged beams of various proportions; but in consequence of the great difference of opinion which still exists as to the comparative strength of flanged beams, a more particular examination of the subject seems to be necessary.

I propose, therefore, to collect from the experiments of Mr. Fairbairn and others, materials for determining the strength of flanged beams, having regard in each case not only to the proportion between the flanges, but to the proportions of all three parts of the beam, namely, those of the top and bottom flanges and of the central rib.

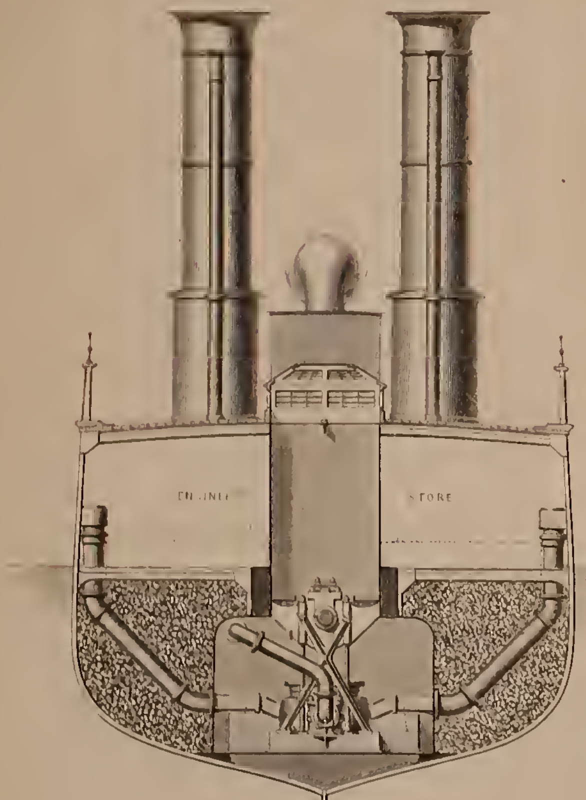
Experiments by Mr. Fairbairn on the transverse strength of flanged beams. Distance between supports, 4 ft. 6 in. Depth of beam, $5\frac{1}{8}$ in.

ENGINES OF SCREW STEAM SHIPS

SCAMANDER, MEANDER AND ARAXES.

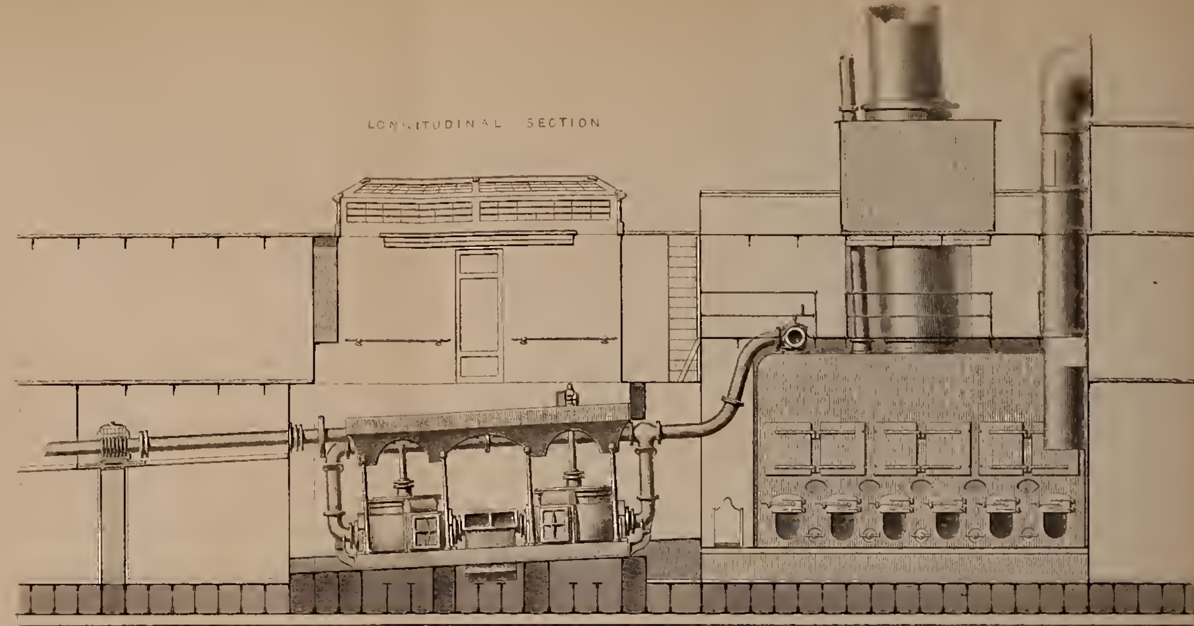
CONSTRUCTED BY MESSRS SLAUGHTER GRUNING & Co

AVONSIDE IRON WORKS BRISTOL

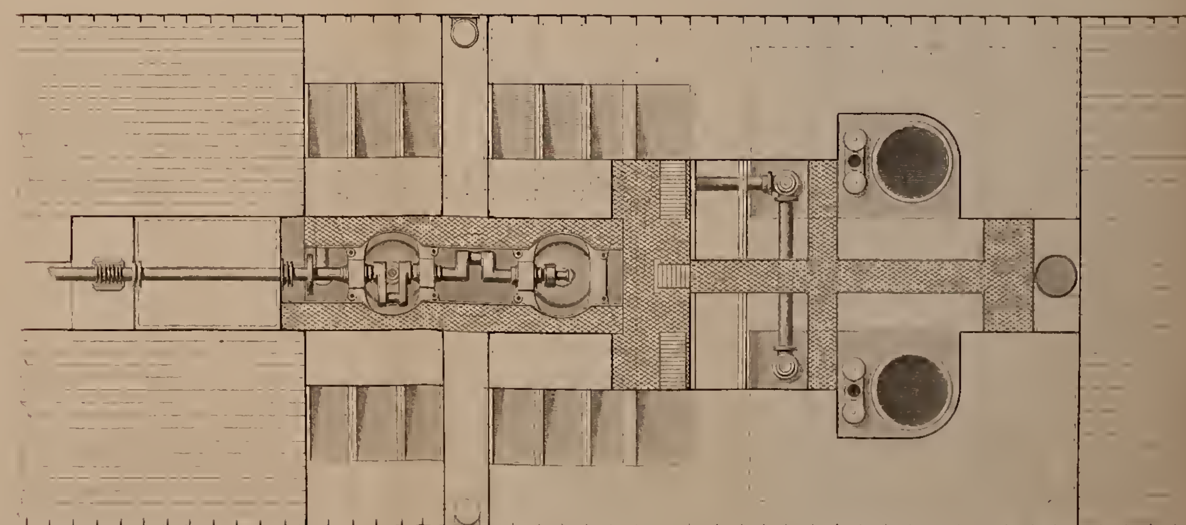


TRANSVERSE SECTION

LONGITUDINAL SECTION



PLAN.



According to the general formula already given, the coefficient n will be $\frac{l\ W}{A\ d}$. Hence, where $\frac{W}{A}$ is the breaking weight in lbs. per square inch of section $\left(\frac{W}{A}\right)\frac{l}{2240\,d} = n$ in tons.

Substituting the proper values for l and d we have $\frac{l}{2240\,d} = \frac{1}{2551}$.

Hence, if we divide $\frac{W}{A}$ by 2551 we obtain the value of n in tons.

Experiment 1.—Flanges 1 : 2.

	Sq. in.	Per centage of whole area.
Area of top flange	·735	26
" bottom ditto	·690	24
" rib	1·395	50
	2·820	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{6678}{2{\cdot}82} = 2368 = \frac{W}{A}, \text{ and } \frac{2368}{2551} = {\cdot}928 = n.$$

Experiment 2.—Flanges 1 : 3.

	Sq. in.	Per centage of whole area.
Area of top flange	·45	16
" bottom ditto	·98	34
" rib	1·44	50
	2·87	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{7368}{2{\cdot}87} = 2567 = \frac{W}{A}, \text{ and } \frac{2567}{2551} = 1{\cdot}006 = n.$$

Experiment 3.—Flanges 1 : 4.

	Sq. in.	Per centage, &c.
Area of top flange	·32	10
" bottom ditto	1·20	40
" rib	1·50	50
	3·02	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{8270}{3{\cdot}02} = 2737 = \frac{W}{A}, \text{ and } \frac{2737}{2551} = 1{\cdot}073 = n.$$

Experiment 4.—No top flange.

	Sq. in.	Per centage, &c.
Area of top flange	0	0
" bottom ditto	1·18	37
" rib	2·02	63
	3·20	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{8270}{3{\cdot}2} = 2584 = \frac{W}{A}, \text{ and } \frac{2584}{2551} = 1{\cdot}013 = n.$$

Experiment 9.—Flanges 1 : 4½.

	Sq. in.	Per centage, &c.
Area of top flange	·357	10
" bottom ditto	1·570	47
" rib	1·443	43
	3·370	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{10727}{3{\cdot}37} = 3183 = \frac{W}{A}, \text{ and } \frac{3183}{2551} = 1{\cdot}248 = n.$$

Experiment 10.—No top flange.

	Sq. in.	Per centage, &c.
Area of top flange	0	0
" bottom ditto	1·219	39
" rib	1·941	61
	3·160	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{8823}{3{\cdot}16} = 2792 = \frac{W}{A}, \text{ and } \frac{2792}{2551} = 1{\cdot}094 = n.$$

Experiment 11.—Flanges 1 : 4.

	Sq. in.	Per centage, &c.
Area of top flange	·5	11
" bottom ditto	2·2	49
" rib	1·8	40
	4·5	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{14462}{4{\cdot}5} = 3214 = \frac{W}{A}, \text{ and } \frac{3214}{2551} = 1{\cdot}260 = n.$$

Experiment 12.—Flanges 1 : 5½.

	Sq. in.	Per centage, &c.
Area of top flange	·49	10
" bottom ditto	2·89	58
" rib	1·62	32
	5·00	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{16730}{5} = 3346 = \frac{W}{A}, \text{ and } \frac{3346}{2551} = 1{\cdot}312 = n.$$

Experiment 13.—No top flange.

	Sq. in.	Per centage, &c.
Area of top flange	0	0
" bottom ditto	1·32	40
" rib	2·00	60
	3·32	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{8942}{3{\cdot}32} = 2693 = \frac{W}{A}, \text{ and } \frac{2693}{2551} = 1{\cdot}056 = n.$$

Experiment 19.—Flanges 1 : 6.

	Sq. in.	Per centage, &c.
Area of top flange	·72	11
" bottom ditto	4·40	69
" rib	1·28	20
	6·40	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{26084}{6{\cdot}4} = 4075 = \frac{W}{A}, \text{ and } \frac{4075}{2551} = 1{\cdot}597 = n.$$

Experiment 20.—Flanges 1 : 6·6.

	Sq. in.	Per centage, &c.
Area of top flange	·64	10
" bottom ditto	4·31	66
" rib	1·55	24
	6·50	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{23249}{6{\cdot}5} = 3576 = \frac{W}{A}, \text{ and } \frac{3576}{2551} = 1{\cdot}402 = n.$$

Experiment 21.—Flanges 1 : 6·8.

	Sq. in.	Per centage, &c.
Area of top flange	·493	9
" bottom ditto	3·315	61
" rib	1·602	30
	5·410	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{21009}{5{\cdot}41} = 3883 = \frac{W}{A}, \text{ and } \frac{3883}{2551} = 1{\cdot}522 = n.$$

Experiment 22.—No top flange.

	Sq. in.	Per centage, &c.
Area of top flange	0	0
" bottom ditto	1·16	37
" rib	2·01	63
	3·17	100

$$\frac{\text{Breaking weight}}{\text{Area}} = \frac{9146}{3{\cdot}17} = 2885, \text{ and } \frac{2885}{2551} = 1{\cdot}131 = n.$$

Other Experiments by Mr. Fairbairn on Larger Beams.

The following was 17 in. deep, 22·5 ft. between supports, and broke with a weight of 22·35 tons.

	Sq. in.	Per centage, &c.
Area of top flange	2·5	10
" bottom ditto	12·0	49
" rib	10·03	41
	24·53	100

$$\text{Here } \frac{W\,l}{A\,d} = \frac{22{\cdot}35 \times 22{\cdot}5}{24{\cdot}53 \times 17} = 1{\cdot}205 = n.$$

Beam 18 in. deep, 27·3 ft. between Supports, Breaking Weight 29·3 tons.

	Sq. in.	Per centage, &c.
Area of top flange	3·125	11
" bottom ditto	15·	51
" rib	11·	38
	29·125	

$$\text{Here } \frac{W\,l}{A\,d} = \frac{29{\cdot}3 \times 27{\cdot}3}{29{\cdot}125 \times 18} = 1{\cdot}526 = n.$$

Girders described at page 197 of "The Artizan" for 1857.

Two girders 22 in. deep and 19 ft. between supports, broke respectively with weights of 50 and 54 tons.

	Sq. in.	Per centage, &c
Area of top flange	4·06	10
" bottom ditto	11·25	28
" rib	24·38	62
	39·69	100

Where breaking weight = 50 tons, we have $\frac{W\,l}{A\,d} = \frac{50 \times 19}{39·69 \times 22}$ $= 1·088 = n$, and

where breaking weight = 54 tons, we have $\frac{W\,l}{A\,d} = \frac{54 \times 19}{39·69 \times 22}$ $= 1·175 = n$.

SUMMARY OF RESULTS IN THE PRECEDING EXPERIMENTS.
Values of n according to the proportions of the beam.

No. of Experiment.	Per centage of whole area.			Value of n.
	Top.	Bottom.	Rib.	
1	26	24	50	·928
2	16	34	50	1·006
3	10	40	50	1·072
4	0	37	63	1·013
9	10	47	43	1·247
10	0	39	61	1·094
11	11	49	40	1·269
12	10	58	32	1·312
13	0	40	60	1·053
19	11	69	20	1·597
20	10	66	24	1·402
21	9	61	30	1·522
22	0	37	63	1·131
Other Experiments.				
	10	49	41	1·205
	11	51	38	1·526
p. 197 ARTIZAN	10	28	62	1·088 / 1·175
Water-street Girder	9	52	39	Breaking weight not ascertained, but judging from the two last experiments the coefficient would probably not be less than $1·35 = n$.

It is impossible to avoid regretting that in the preceding experiments the breaking weight was not ascertained for rectangular bars of the same iron as that which was used for the flanged beams. The Table at page 171 of THE ARTIZAN shows that, among sixty specimens of cast iron experimented on by Mr. Hodgkinson and Mr. Fairbairn, the coefficients varied from ·717 to 1·167; so that certain kinds of cast iron are more than 50 per cent. stronger than others. Now there is nothing to show the absolute strength of rectangular bars cast from the same iron as that used for Mr. Fairbairn's flanged beams; so that one is entirely at a loss to know whether the coefficients in the preceding page are to be compared with rectangular bars whose coefficient is ·717 or 1·167, or some uncertain coefficient between these two extremes. The probability is, that a rectangular bar of the same iron would have a coefficient something less than ·9, as the weakest of the flanged beams, namely, one with equal flanges, probably little stronger than a rectangular bar, has only a coefficient equal to ·928. According to this, the quality of iron used for the flanged beams would seem to have been something like a mean between the best and the worst iron tried in the form of rectangular bars. On the other hand, it will be seen, from the composition of the iron given in a former page of THE ARTIZAN, that this composition indicates iron of superior quality, which ought to have produced a coefficient much higher than ·9. This makes the difficulty still greater of deciding what was the absolute strength of the iron used in these experiments on flanged beams, and without a most perfect knowledge on this subject the experiments, as already explained, cannot be considered conclusive or satisfactory.

In the "Engineer's Pocket Book" for 1856 an extensive Table is inserted, showing the dimensions of flanged beams calculated to support various ascertained weights. I propose to examine, in the same method as I have already used for Mr. Fairbairn's experiments, the proportions of a number of these beams, and the coefficient which has been used in calculating their strength.

GIRDERS 30 FT. LONG BETWEEN SUPPORTS, AND 36 IN. DEEP.

Example 1.—Breaking weight 223 tons.*

	Sq. in.	Per centage, &c.
Area of top flange	16·0	9
„ bottom ditto	96·0	53
„ rib	69·0	38
	18·10	100

Then $\frac{W\,l}{A\,d} = \frac{223 \times 30}{181 \times 36} = 1·025 = n.$

Example 2.—Breaking weight 210 tons.

	Sq. in.	Per centage, &c.
Area of top flange	15·0	9
„ bottom ditto	90·0	52
„ rib	67·0	39
	172·0	100

Then $\frac{W\,l}{A\,d} = \frac{210 \times 30}{172 \times 36} = 1·017 = n.$

Example 3.—Breaking weight 195 tons.

	Sq. in.	Per centage, &c.
Area of top flange	14·	8
„ bottom ditto	84·	48
„ rib	78·	44
	176·	100

Then $\frac{W\,l}{A\,d} = \frac{195 \times 30}{176 \times 36} = ·923 = n.$

Example 4.—Breaking weight 180 tons.

	Sq. in.	Per centage, &c.
Area of top flange	13·12	9
„ bottom ditto	78·00	53
„ rib	56·48	38
	147·60	100

Then $\frac{W\,l}{A\,d} = \frac{180 \times 30}{147·6 \times 36} = 1·016 = n.$

Example 5.—Breaking weight 165 tons.

	Sq. in.	Per centage, &c.
Area of top flange	12·0	8
„ bottom ditto	73·5	49
„ rib	63·22	43
	148·72	100

Then $\frac{W\,l}{A\,d} = \frac{165 \times 30}{148·7 \times 36} = ·925 = n.$

Example 6.—Breaking weight 150 tons.

	Sq. in.	Per centage, &c.
Area of top flange	11·625	9
„ bottom ditto	65·625	50
„ rib	53·156	41
	130·406	100

Then $\frac{W\,l}{A\,d} = \frac{150 \times 30}{130·4 \times 36} = ·953 = n.$

GIRDERS 24 IN. DEEP, AND 20 FT. BETWEEN SUPPORTS.

Example 7.—Breaking weight 60 tons.

	Sq. in.	Per centage, &c.
Area of top flange	5·625	9
„ bottom ditto	26·00	44
„ rib	27·398	47
	59·023	100

Then $\frac{W\,l}{A\,d} = \frac{60 \times 20}{59·023 \times 24} = ·847 = n.$

Example 8.—Breaking weight = 57 tons.

	Sq. in.	Per centage, &c.
Area of top flange	4·50	8
„ bottom ditto	24·00	45
„ rib	25·086	47
	53·586	100

Then $\frac{W\,l}{A\,d} = \frac{57 \times 20}{53·586 \times 24} = ·886 = n.$

Example 9.—Breaking weight 54 tons.

	Sq. in.	Per centage, &c.
Area of top flange	4·000	8
„ bottom ditto	22·500	45
„ rib	23·765	47
	50·265	100

Then $\frac{W\,l}{A\,d} = \frac{54 \times 20}{50·265 \times 24} = ·895 = n.$

* The weight given in the table is in all cases the safe distributed load which the beam is calculated to bear, and this is assumed to be one-fourth of the absolute breaking weight of the beam. Hence, the breaking weight distributed will be four times the breaking weight in the tables; and, as I have used W = the breaking weight in the centre, I have in each case taken W = twice the weight in the tables, or twice the safe distributed load.

Example 10.—Breaking weight 51 tons.

	Sq. in.	Per centage, &c.
Area of top flange	3·281	7
„ bottom ditto	20·625	44
„ rib	22·843	49
	46·749	100

Then $\frac{W\,l}{A\,d} = \frac{51 \times 20}{46{\cdot}749 \times 24} = {\cdot}917 = n.$

Example 11.—Breaking weight 36 tons.

	Sq. in.	Per centage, &c.
Area of top flange	2·437	7
„ bottom ditto	15·750	42
„ rib	19·140	51
	37·327	100

Then $\frac{W\,l}{A\,d} = \frac{36 \times 20}{37{\cdot}327 \times 24} = {\cdot}803 = n.$

Example 12.—Breaking weight 31 tons.

	Sq. in.	Per centage, &c.
Area of top flange	2·437	7
„ bottom ditto	14·875	42
„ rib	17·773	51
	35·085	100

Then $\frac{W\,l}{A\,d} = \frac{31 \times 20}{35{\cdot}085 \times 24} = {\cdot}736 = n.$

Example 13.—Breaking weight 30 tons.

	Sq. in.	Per centage, &c.
Area of top flange	2·234	7
„ bottom ditto	13·812	41
„ rib	17·773	52
	33·819	100

Then $\frac{W\,l}{A\,d} = \frac{30 \times 20}{33{\cdot}819 \times 24} = {\cdot}739 = n.$

GIRDERS 18 IN. DEEP.

Example 14.—Breaking weight 80·8 tons. Distance between supports 18 ft. = *l*.

	Sq. in.	Per centage, &c.
Area of top flange	7·90	11
„ bottom ditto	41·25	59
„ rib	21·33	30
	70·48	100

Then $\frac{W\,l}{A\,d} = \frac{80{\cdot}8 \times 18}{70{\cdot}5 \times 18} = 1{\cdot}146 = n.$

Example 15.—Breaking weight 72 tons. Distanee between supports 16 ft. = *l*.

	Sq. in.	Per centage, &c.
Area of top flange	5·625	10
„ bottom ditto	31·875	56
„ rib	19·59	34
	57·090	100

Then $\frac{W\,l}{A\,d} = \frac{72 \times 16}{57{\cdot}1 \times 18} = 1{\cdot}121 = n.$

Example 16.—Breaking weight 64 tons. Distanee between supports 16 ft. = *l*.

	Sq. in.	Per centage, &c.
Area of top flange	5·06	9
„ bottom ditto	29·75	55
„ rib	19·59	36
	54·40	100

Then $\frac{W\,l}{A\,d} = \frac{64 \times 16}{54{\cdot}4 \times 18} = 1{\cdot}046 = n.$

Example 17.—Breaking weight 56·2 tons. Distanee between supports 15 ft. = *l*.

	Sq. in.	Per centage, &c.
Area of top flange	3·28	8
" bottom ditto	19·50	51
„ rib	15·94	41
	38·72	100

Then $\frac{W\,l}{A\,d} = \frac{56{\cdot}2 \times 15}{38{\cdot}7 \times 18} = 1{\cdot}210 = n.$

GIRDERS 12 IN. DEEP AND 20 FT. BETWEEN SUPPORTS.

Example 18.—Breaking weight 60 tons.

	Sq. in.	Per centage, &c.
Area of top flange	10·50	13
„ bottom ditto	53·75	69
„ rib	13·59	18
	77·84	100

Then $\frac{W\,l}{A\,d} = \frac{60 \times 20}{77{\cdot}84 \times 12} = 1{\cdot}285 = n.$

Example 19.—Breaking weight 57 tons.

	Sq. in.	Per centage, &c.
Area of top flange	8·312	11
„ bottom ditto	51·250	71
„ rib	12·800	18
	72·362	100

Then $\frac{W\,l}{A\,d} = \frac{57 \times 20}{72{\cdot}362 \times 12} = 1{\cdot}313 = n.$

Example 20.—Breaking weight 54 tons.

	Sq. in.	Per centage, &c
Area of top flange	7·875	12
„ bottom ditto	45·000	69
„ rib	12·375	19
	65·250	100

Then $\frac{W\,l}{A\,d} = \frac{54 \times 20}{65{\cdot}25 \times 12} = 1{\cdot}379 = n.$

Example 21.—Breaking weight 51 tons.

	Sq. in.	Per centage, &c.
Area of top flange	8·25	13
„ bottom ditto	45·00	68
„ rib	12·59	19
	65·84	100

Then $\frac{W\,l}{A\,d} = \frac{51 \times 20}{65{\cdot}84 \times 12} = 1{\cdot}291 = n.$

Example 22.—Breaking weight 48 tons.

	Sq. in.	Per centage, &c.
Area of top flange	7·125	12
„ bottom ditto	40·000	66
„ rib	13·810	22
	60·935	100

Then $\frac{W\,l}{A\,d} = \frac{48 \times 20}{60{\cdot}935 \times 12} = 1{\cdot}313 = n.$

Example 23.—Breaking weight 42 tons.

	Sq. in.	Per centage, &c.
Area of top flange	6·19	12
„ bottom ditto	35·00	67
„ rib	10·93	21
	52·12	100

Then $\frac{W\,l}{A\,d} = \frac{42 \times 20}{52{\cdot}12 \times 12} = 1{\cdot}344 = n.$

Example 24.—Breaking weight 36 tons.

	Sq. in.	Per centage, &c.
Area of top flange	5·31	11
„ bottom ditto	32·00	65
„ rib	11·86	24
	49·17	100

Then $\frac{W\,l}{A\,d} = \frac{36 \times 20}{49{\cdot}17 \times 12} = 1{\cdot}220 = n.$

Example 25.—Breaking weight 31 tons.

	Sq. in.	Per centage, &c.
Area of top flange	4·78	10
„ bottom ditto	30·00	66
„ rib	10·94	24
	45·72	100

Then $\frac{W\,l}{A\,d} = \frac{31 \times 20}{45{\cdot}72 \times 12} = 1{\cdot}129 = n.$

Example 26.—Breaking weight 30 tons.

	Sq. in.	Per centage, &c.
Area of top flange	4·250	11
„ bottom ditto	25·310	63
„ rib	10·687	26
	40·247	100

$$\text{Then } \frac{W\,l}{A\,d} = \frac{30 \times 20}{40{\cdot}247 \times 12} = 1{\cdot}242 = n.$$

SUMMARY OF PRECEDING RESULTS.

No. of Example.	Per Centage of Whole Area. Top.	Bottom.	Rib.	Value of n.	Whole Area.	Breaking Weight.
	Girders 36 in. deep and 30 ft. between supports.					
					Square Inches.	Tons.
1	9	53	38	1·025	181	223
2	9	52	39	1·017	172	210
3	8	48	44	·923	176	195
4	9	53	38	1·016	148	180
5	8	49	43	·925	149	165
6	9	50	41	·953	130	150
	Girders 24 in. deep, and 20 ft. between supports.					
7	9	44	47	·847	59	60
8	8	45	47	·886	54	57
9	8	45	47	·895	50	54
10	7	44	49	·917	47	51
11	7	42	51	·803	37	36
12	7	42	51	·736	35	31
13	7	41	52	·739	34	30
	Girders 18 in. deep; distance between supports from 18 ft. to 15 ft.					
14	11	59	30	1·146	70	81
15	10	56	34	1·121	57	72
16	9	55	36	1·046	54	64
17	8	51	41	1·210	39	56
	Girders 12 in. deep, and 20 ft. between supports.					
18	13	69	18	1·285	78	60
19	11	71	18	1·313	72	57
20	12	69	19	1·379	65	54
21	13	68	19	1·291	66	51
22	12	66	22	1·313	61	48
23	12	67	21	1·344	52	42
24	11	65	24	1·220	49	36
25	10	66	24	1·129	46	31
26	11	63	26	1·242	40	30

On comparing this Table with the coefficients derived by Mr. Fairbairn, it will be observed that the latter are invariably greater, which may be explained by the fact, that the author of the Table in the "Engineer's Pocket Book" has used a coefficient of 2, instead of $2\frac{1}{6}$, in the formula for the bottom flange area. Thus his formula is,

$$W = \frac{2\,a\,d}{l}, \text{ instead of } \frac{2{\cdot}1\dot{6}\,a\,d}{l}.$$

The author of the Table has adopted the vicious principle of applying a coefficient to the bottom flange, instead of the whole area; and, secondly, there are great discrepancies between the series of coefficients for girders 24 in. deep compared, on the one hand, with deep girders of 36 in., and, on the other hand, with shallower girders of 18 and 12 in. in depth.

Thus, among the examples in the preceding summary, there are girders in which the bottom flange is only 41 per cent. of the whole area, while there are others in which the bottom flange is 71 per cent. In the former case the coefficient is ·739, and in the latter 1·313, or nearly in the ratio indicated by the per centages of the bottom flange areas. In fact, if the Table had been strictly and mathematically correct, this proportion would obtain precisely, namely, the coefficients would be directly as the per centages of the bottom flange; and, apart from trifling errors in the dimensions of the girders, this proportion is tolerably well observed throughout the Table.

The same general proportion runs throughout the coefficients in the Table derived from Mr. Fairbairn's experiments; these increasing or decreasing as the per centage of the bottom flange becomes greater or less.

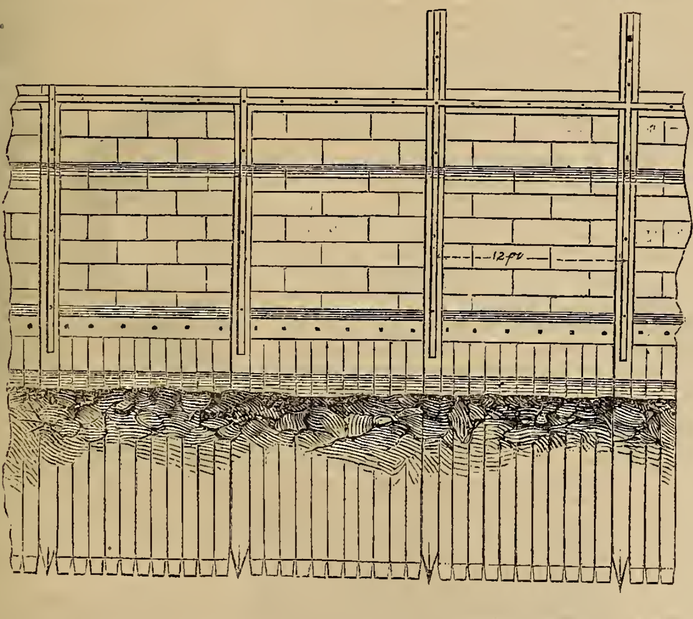
To be continued.

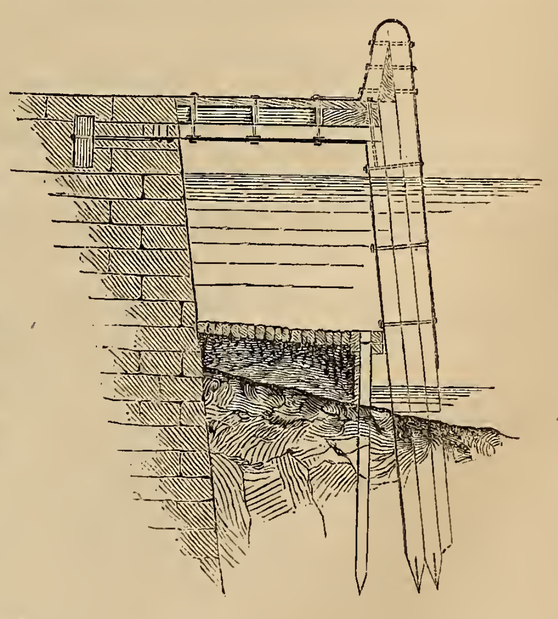
NEW TIMBER WHARVES, DUBLIN.

THE trade of the port of Dublin is so rapidly increasing that it has been considered advisable to improve the present accommodation by deepening the river alongside of the present quays at the North-wall. To accomplish this in the best manner for the locality, the timber wharves or jetties were designed, as shown in our illustration, and are now about to be erected.

The object aimed at is to bring the quay-face nearer to the centre of the stream, and thus prevent the necessity of dredging, or otherwise deepening the river, close into the quay walls, which would endanger their stability, they being built almost on the surface of the river bed.

It is contemplated to erect two of these wharves, one between the present eastern wharf and Fish-street, and the other in front of the timber yard of the





NEW TIMBER WHARVES, DUBLIN.

Messrs. Martin and Sons; the first to be 400 ft. in length and 14 ft. in breadth, and the second 300 ft. by 10 ft.: this wharf will be also something stronger than the other, but in general the section we have given will answer for either.

It is proposed to dredge the excavation in the first instance to a depth of 4 ft., which is to be further deepened as the piling advances to a depth of 6 ft. below the present level; the first dredging is to lessen the friction of the piling, which (if we may judge by the example of the graving dock) will be considerable. The sheet piles are to be not less than 25 ft. in length, of half balk, sawn to parallel breadth, to dress $6\frac{1}{2}$ in. in thickness; they are to be driven between double tiers of guide wales, and finished with permanent wales on outside of 13 × 9 in., and on inside 13 × $6\frac{1}{2}$, which are to be bolted to the sheeting piles by 1 in. screw-bolt passing through every second pile and inner and outer wales; these wales are to be not less than 25 ft. long each, and scarfed at their junctions.

The double main piles are to be of whole balk Memel timber 13 × 13, placed 12 ft. apart from centre to centre, to be driven to a batter of $1\frac{1}{2}$ in. to 1 ft. to at least 21 ft. below low-water of spring tides. This will be a difficult job, and we would say only attainable with a steam piling engine; the depth of 21 ft. in the stiff gravel that forms the alluvial subsoil of that portion of the river bed is surely more than is necessary for the stability of the work, and from our knowledge of the locality we would say 10 ft. would be amply sufficient; in fact, we doubt very much whether any contractor likely to tender for such a

small job would have the necessary plant; and the directions contained in the specification as to the weight of the rams to be used, when taken in connection with the depths to be arrived at, are calculated to provoke a smile; for instance, it is specified that the sheet piles are to be driven with rams weighing at least 15 cwt., and main and fender piles with rams weighing not less than 20 cwt.

The platform is to have a fall of 2 in. in its breadth, and is to be also of Memel timber plank, 6 in. in thickness, resting on longitudinal joists or sleepers, of half balk, which are borne by the cross bearers of whole balk Memel. These cross bearers have a bearing in the wall of 18 in., and on the top of the inner main pile, to which they are secured by a long bolt, that passes through the platform and into the main pile.

In the lengths of the new wharves are to be placed two sets of fender piles, rising above the platform level 5 ft., and forming bays, to protect the wharves from the paddle-boxes of steam-vessels. These fenders are shown on the elevation and section, and are bound together with plates and knees of iron $4\frac{1}{2}$ in. × $1\frac{1}{2}$ in., for 9 ft. vertically below the platform level; for the other 5 ft. they taper to 1 in. At every third pile, and at every fender-pile, 36 ft. asunder, wrought-iron tie-rods are to be bolted to the underside of the cross bearers, and to granite anchor pieces, 3 ft. by 15 in. × 13 in.

Between the top of the sheet piling and old quay wall the space is to be filled in with gravel and stiff clay and pitch, paved over all with 10-in. granite paving, laid with a fall of 1 in 12.

Up the front face of each fender-pile a wrought-iron strap is secured, and being continued over the beads of the fender-pile and back strut, is bolted with $1\frac{1}{4}$ in. bolts, as shown. The oak coping, shown along length of front elevation, is 18 in. × 12 in., and the platform is framed together; the inner ends of horizontal timbers rest on quay wall, and, in addition, are thoroughly tied in by means of wrought iron bars to granite blocks, as seen in transverse sectional view.

The pile shoes for the main piles are to be of best scrap iron, and average about 40 lbs. each. The sheeting pile shoes, of cast iron, are to weigh about 65 lbs. each. The works are to be carried on under the superintendence of the foreman appointed by the engineer of the Ballast Board, and subject to the engineer's approval.

The scale to which the illustration is drawn is 1-12th of an inch to a foot.

THE BOYNE VIADUCT.

A matter of considerable interest to the engineering profession has come before the public within the last few weeks connected with that stupendous work, the Boyne Viaduct.

It appears that, during the late parliamentary inquiry into the county surveyorships of Ireland, a certain Mr. Galbraith, of considerable scientific and literary attainments, of Trinity College, Dublin, was examined, and, amongst other evidence, stated—in proof of the superiority of the education received in the engineering class of his college—that a Mr. Barton, who had been a pupil of that class, was the designer of the Boyne Viaduct. This did not reach the ears of Sir John Macneill until the report of the committee was published, when that gentleman at once wrote to Mr. Galbraith, correcting him on the subject. The learned professor lost no time in sending Sir John's letter to Mr. Barton, and a very lengthy reply was the result, in which Mr. Barton not only claimed the merit of the work, but, with a striking want of taste towards his former good friend and employer, attempted to censure Sir John Macneill.

To persons not acquainted with the workings of the profession, and to the general public, who were not of course familiar with the relations in which Sir John Macneill stood to Mr. Barton, the latter gentleman's letter would appear all gospel.

The true state of the case will be found to be pretty much as follows:—About the year 1844, Sir John Macneill found it would be expedient, for the purpose of uniting the Belfast Junction with the Dublin and Drogheda Railway, to cross the Boyne, below Drogheda, at a considerable altitude—about 102 ft. at low, and 95 ft. at high water level, and, to meet the requirements of the Admiralty, the spans of his bridge should be considerably greater than anything that had at that time been attempted. Having succeeded in spanning the Royal Canal by a lattice bridge of 286 ft. in clear between the abutments, he very naturally designed a lattice bridge on a larger scale for the Boyne Viaduct; and fourteen years later Mr. Barton, at that time in the engineering school of Trinity College, steps forward to claim the merit of that design.

That there were modifications of the original design planned since by various parties we are not disposed to deny, but we contend that Sir John's design was an iron lattice girder bridge, and such has been built. And it may appear strange that Mr. Barton had not the slighest hand even in the drafting of the design, which, with the original details, was committed to the care of a Mr. Bunting, who, with Messrs. Murray, Bryson, Sloane, Pontet, Armstrong, and one or two others, whose names we do not at this moment remember, in the back drawing-room of No. 27, in Rutland Square, made the original set of plans of the original design, which (excepting some details, that may have been afterwards suggested by Mr. Barton, when he had acquired ten years' experience) have been built to. At the time we write of, Mr. Barton was assisting in making enlarged plans for the parliamentary drawings of the Mullingar (now the Midland Great Western) Railway, and attending college, and afterwards resident at the Arklow Harbour Works.

If such assumptions on the part of assistants were permitted, the great heads of the profession would lose their just merits as original designers. The engineer designs the work; it is for his assistants to carry out the details. It is said that a Mr. Blood made the necessary calculations connected with the Boyne Viaduct.

LIGHTHOUSES OF IRELAND.

Two new houses are about being built on the Irish coast, one on the Calf Rock, off the west coast of the county Cork; and one on the Black Rock, opposite to the entrance to Blacksod Bay, in county Mayo. The situations of both houses are exceedingly wild, that of the Calf Rock especially; it is situate nearly midway between the Fastnet and Skelligs Rocks, and according to the design submitted to the Board of Trade will be of cast-iron, about 90 ft. in height above the top of the rock. Mr. Halpin is the engineer; and, although adhering very closely to his plan of the Fastnet Lighthouse, which has so successfully braved the storms of the past six or seven years, he has made several improvements in his design, which will no doubt be of great importance.

The Black Rock Lighthouse will be of stone, and tenders are advertised for its erection.

The annual inspection of the Irish lights, or rather the first trip, commenced on the 4th ult., and ended on the 15th. The commissioners, accompanied by their engineer, Mr. Halpin, and marine inspector, Captain Roberts, R.N., left the harbour of Kingston in the Trinity yacht *Vestal*, having several of Herbert's patent buoys on board, which were placed in positions on the coast by Capt. Roberts, to test their durability and efficiency. The yacht proceeded to Cork, visiting on its way the lighthouses at Tuskar, Hook Tower, Ballycottin Island, &c., and continued in a southern direction to the Calf Rock, from whence, after visiting the Skelligs lights, they proceeded to the Foze, one of the Blasgets, where it is intended to build a lighthouse. This rock, which is a quartz protrusion, rises out of the sea abruptly to the height of 98 feet, and offers a fine but exceedingly difficult situation for a lighthouse; the surrounding rocks are of Valentia slate, and the celebrated quarries are within a few miles. The commissioners effected a landing, with much trouble, on the Black Rock, where, after partaking of a slight luncheon, and drinking success to the undertaking and the health of the engineers, they left for Sligo.

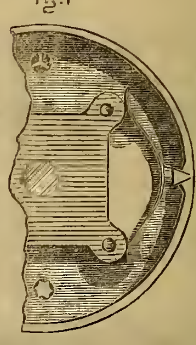
The second trip of the commissioners is settled for the 16th of August.

IMPROVEMENTS IN PISTONS.

We give the accompanying illustration of a very important, but exceedingly simple invention, by Messrs. Molineaux and Nichols, of the Brighton Railway Locomotive Works, for superseding the use of metal springs for expanding metallic piston packings. They simply bore the sides of the piston truly, and fit into the hole so bored a double-hinged spindle valve, as shown in accompanying illustration. The two valve faces are expanded by a spring, and kept close against the interior faces of the piston plates, surrounding the holes bored therein, and upon the steam being admitted on either side of the piston, the valve is acted upon thereby and opened, and thus the full pressure of the steam is brought to bear within the annular space or chamber in the piston, and so acting behind the metallic packing expands it; upon the direction of the motion of the piston being changed, the steam will act on the opposite side of the piston, and also upon the opposite end of the double-spindle valve, and, as before, the pressure of the steam will be permitted to enter the piston, and so be communicated to the back of the piston packing, as before.

Fig. 2.

Fig. 1



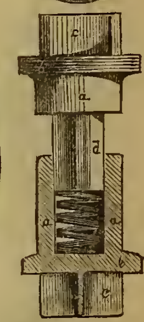


Fig. 3.

Many attempts have been made to employ the elastic pressure of steam and the pressure of fluids to expand pistons and bucket packings, by means of hollow piston rods with lateral openings into the piston, by means of small holes drilled in the ring of single body pistons, and by other means, but practically, so far as we know, none of these have ever been sufficiently successful to permit of their being continued in use. Now the present invention has been practically tested in the most severe and sufficient manner, and we have watched with considerable interest these trials, and we are enabled to state that they have proved entirely successful; and one point which is of considerable importance is, that no loss of steam results from its use, the piston space not being, as might be supposed, filled and emptied at each stroke; as, indeed, after the piston has been once filled with steam, it is but the pressure which is communicated alternately at one side and the other, the original volume remaining unchanged.

For locomotive engines there is a very great advantage pertaining to this plan, viz., that when the steam is shut off, as when descending inclines, &c., the pressure is removed, and the friction which would be due to the constant pressure of metal springs does not occur.

INSTITUTION OF CIVIL ENGINEERS.

After the meeting on the 23rd March, a model was exhibited in the Library of Mr. Smith's "Fly-Vane Governor."

The tendency of a vane rotating rapidly to assume a direction parallel to the plane of its motion, was by this invention made available for the purpose of a speed governor for any machinery in motion. In the model, three vanes were connected by arms to a boss, free to slide upon a shaft, round which the vanes rotated. The upper ends of the vanes were secured by connecting-bars, jointed

at each end, and attached to a lever, which enabled the set of the vanes, or their angle in relation to the shaft, to be varied for the purpose of regulating the speed. According to the set thus given, the vanes might rotate with a corresponding velocity without rising; but when this velocity was in the least degree exceeded, the lower end of the vanes rose, and, carrying up with them the boss on the shaft, set in motion whatever gearing or apparatus might be applied for working a slide or throttle valve.

The advantages presumed to be gained by this governor were, greater simplicity and cheapness of construction, and greater sensibility to the action of the prime mover. No inertia was created, requiring time to subside, as with the ball governor; the weight of the vane-wheel being of no practical importance, the boss descended as soon as the decreased velocity no longer altered the set or inclination of the vanes. This set or inclination could be altered whilst the machinery was in motion, so as to regulate the maximum speed. It was not necessary for its proper action that the shaft should be in a vertical position, so that it was applicable as a governor for the engines of a vessel at sea, in the roughest weather.

March 30, 1858.

Charles Hutton Gregory, Member of Council, in the Chair.

The proceedings were commenced by the reading of the following abstract of a Paper entitled "Observations on the Electrical Qualifications requisite in long Submarine Telegraph Cables." By Mr. Alfred Varley.

The communications lately read, and so fully discussed, on the subject of submarine telegraphy, had suggested the inquiry, whether the cables, as at present constructed, did fulfil, in the best manner, the electrical portion of the problem. It was remarked that there appeared to be some uncertainty, in the minds of those engaged in applying electricity telegraphically, regarding the laws of conduction and induction, and consequently of the nature of the conductor to be employed in long submarine circuits. The conclusions arrived at by the projectors of the Atlantic cable were referred to, as it was believed that some errors had been inadvertently introduced into their calculations; but it was trusted that these criticisms would be received in a friendly spirit, as the only desire was to arrive at the truth.

The laws of conduction, as ascertained by the author, as the result of direct experiments, were—1st, That a wire 1 mile long offered half the resistance of one 2 miles long. 2nd, That two wires, each 2 miles long, when placed side by side, which was the same as one of double the area, offered the same resistance as one wire 1 mile long. With regard to induction, the results of experiments tried by the Author and Mr. C. John Varley showed that with flat plates it followed the same law as conduction, decreasing in regular proportions as the insulating medium was increased; that was to say, if the inductive force through one plate was twelve, through two plates it would be six, through three plates four, and so on. In a gutta percha covered wire it probably did not follow precisely the same law, as when the insulating materials were increased in depth, the surface was also enlarged, which partly counteracted the effect of greater thickness. Mr. C. J. Varley had tried some experiments which went to show that in a wire 1-10th of an inch in diameter, coated to the depth of 1-10th of an inch with gutta percha, making a total of 3-10ths, when compared with one of the same size, coated to twice that depth, the inductive force of the former was to the latter as 4 to $3\frac{1}{4}$, or thereabouts, and not 4 to 2; but this result was only to be considered as an approximation.

The conclusion arrived at by the projectors of the Atlantic Telegraph that, in a submarine cable, a small wire conducted more rapidly than a large one, was thought to be erroneous. If a battery of six cells, with 6 in. of surface in each shell, was connected through a circuit of nominally no resistance, a much greater quantity of electricity would be found to pass than when connected through a long fine wire perfectly insulated. In a battery with the same number of cells, but with twice the surface, and capable, consequently, of giving out twice the quantity, through a circuit of nominally no resistance, no more, practically, would be found to be passing, the resistance of the wire measuring out the amount, something in a similar way to water flowing out of a small pipe inserted into the bottom of a cistern. The series might be added to, cell by cell, until, practically, as much was forced through as the battery originally generated, along a circuit of nominally no resistance. After this had been arrived at, a further addition would not make any perceptible difference, as there was already power enough to force through all that the battery was capable of generating, and the amount of force given out was always proportionate to the dynamic quantity flowing through the instruments. Intensity was only the medium which forced through this dynamic quantity.

The three following conclusions, which had been introduced into previous discussions, were then referred to:—1st, That a submarine circuit was a Leyden jar, which had to be charged to saturation, before passing a signal through; and consequently, the smaller it was the sooner it was charged, therefore following a different law to that of a suspended wire, which probably followed the law of squares; 2nd, That the rapidity of signalling with voltaic currents was not affected by the intensity of the battery; and 3rd, That magneto-electric currents travelled more rapidly than voltaic ones, and also increased in rapidity when their intensity was increased. The Author, in differing from these conclusions, did not wish it to be understood that he thought the law of squares applied to submarine wires, for he knew of no electrical phenomenon which obeyed this law. It was submitted that there was a material difference between a Leyden jar and a submarine circuit. In a Leyden jar the inner and outer coatings were perfectly insulated from each other. If they were not insulated, there could be no statical charge; induction, therefore, involved insulation. The fact was frequently overlooked, that the only real insulation in a submarine circuit was the resistance opposed by the wire to the passage of the current, for it united both, being in contact with the earth at both ends. If it offered no resistance, there would be no insulation, and, consequently, no induction; and in proportion to the resistance it offered, providing always the insulating medium was of the same thickness, would induction be manifested. In the case of a suspended wire, the insulating medium of the air took the place of the gutta percha of a submarine cable. The earth, the nearest conductor, being a long way off, and only on one side, no large amount of induction could take place between the earth and the wire; nevertheless it did take place to a certain appreciable extent. Indications of it had been noticed in a circuit 60 miles long, and it was believed that it could be perceived in much shorter circuits with delicate apparatus. If the wire was brought nearer to the earth, induction would be developed more strongly, and it might be brought down, step by step, until the condition of a submarine wire was approached, where the earth surrounded the wire on all sides, and was only separated from it by the 3-16ths of an inch of gutta percha, a substance possessing specifically a very much greater inductive capacity than air.

It was mentioned, that a wire of a given length offered the same resistance to a given quantity of electricity, that a wire of double the length did to half the dynamic amount. From this it was deduced that all wires offered an infinitely small resistance to an infinitely small amount of electricity. The action of a battery when connected to send a current along a submarine wire was then considered, and it was remarked, that the wire and the earth being only separated by the thin layer of gutta percha, induction could readily take place. Whilst the wire itself opposed great resistance to the quantity of electricity the battery was capable of generating, the effect would be to form a wave throughout the wire; but as there was but little resistance, comparatively speaking, to induction taking place, the greater portion of the first impetus would be occupied in charging the wire statically near the battery end. A very minute amount would begin immediately to flow at the further extremity, and in proportion as the tension of the wave of charge rose throughout the wire, so would the flow increase, both reaching their maximum together. When the wire was disconnected from the battery, this current would continue to flow out in a decreasing stream, as the tension of the wave of charge lowered, both ceasing at the same time. In the case of a submarine wire, it was asserted, that as no induction worth naming could take place, there could be no accumulation of statical charge worth noticing; the whole impetus was therefore directed forward, and not diverted laterally, consequently signals were found, for all practical purposes, to pass instantly. In the case of a submarine wire, the time elapsing between the contact of the battery and the appearance of the current, would be dependent on the sensitiveness of the instruments to record small amounts of electricity.

The relative amount of induction was decreased when the wire was enlarged, for whilst the substance increased as the square, the resistance decreasing in the same proportion, the surface on which induction depended only increased in regular proportion. Supposing four cables were employed as one conductor, although there would be only one-fourth of the resistance, signals would not pass through more quickly than through one, for the inductive surface was also increased four times; but if these cables were merged into one, whilst the inductive surface would be reduced one-half, the resistance would not be increased. It was believed, therefore, that if the diameter of a conductor was doubled, signals would pass through twice as quickly with the same depth of insulation.

The relations subsisting, telegraphically, between quantity and intensity of electric currents, demonstrated, that if the insulation was imperfect, larger dynamic quantities gave a better chance of working through. Cases had occurred where increasing the intensity of the battery had produced no perceptible advantage, whilst increasing the surface in each cell had a very decided effect. A case was instanced where, on a leaky circuit of upwards of 212 miles in length, the deflection on the galvanometer had been raised from 23° to 53°, by increasing the surface without adding to the number of cells.

The effect of employing batteries of very high intensities for submarine wires, with a view to increased rapidity of signalling, was then considered; and it was stated that, as with high intensities there was greater energy to force through resistance, the wave of charge would arrive at its maximum more quickly than with a lower intensity, and signals would be passed through sooner. The reason why an increase in the rate with voltaic currents had not hitherto been observed, when the intensity of the battery had been increased, was explained.

The results with magnetic electric currents would, it was thought, be more decided, for their intensity was many times as great as that of the voltaic currents which had been employed. For instance, it would take twelve hundred cells to spark through a space of air only one hundredth of an inch; but this intensity would be a very low one for a magneto-electric current, whose intensity could be increased to almost any extent. A voltaic battery might be compared to a hydraulic ram, and a mageto-electric machine to a fly-press; both might be capable of raising a given weight, but one would do it more suddenly than the other.

In conclusion, it was remarked that it was impossible to believe that Nature, whose laws Science, as she progressed, invariably proved to be simpler and yet more simple, should have one law for one conductor and another for another; and that electric currents, having all the same properties in common, should be differently affected when their intensity was increased or diminished.

The second Paper read was "Description of the Improvements on the Second Division of the River Lee Navigation, with Remarks on Canals generally." By Mr. R. C. Despard.

In the year 1854, Mr. Beardmore, M. Inst. C.E., communicated to the Institution an account of the works on the first division of this navigation, extending from the Thames to Old Ford Lock, entirely within tidal influence. The second division commenced at Old Ford and terminated at Tottenham, a distance of $4\frac{1}{2}$ miles. The works on the latter division, which were not proceeded with until the end of 1855, consisted of—

First—The removal of Old Ford Lock, and the construction on its site of a pair of locks of greater width and increased depth of water over the sills.

Second—The construction of wharf and towing-path walls, and raising the

old or forming new banks between Old Ford and Homerton Lock, a distance of 1 mile 3 furlongs. Also removing Homerton Lock, so as to make the whole length, from Old Ford to Tottenham, into one level.

Third—The construction of a pair of stop-gates and a new bridge at Pond Lane, between Homerton Lock and Lee Bridge; and

Fourth—Deepening, by means of dredging, the main river from Homerton Lock to Tottenham.

The works for the Old Ford Locks were commenced by forming a cofferdam, consisting of a single row of whole timber piles, below the old lock; a trench having been previously excavated, which was filled up on the outside of the piles with puddle, to within 4 ft. of Trinity high-water mark. This dam remained perfectly sound and water-tight during the whole of the operations. A "stank" having been placed across the upper level of the navigation, the removal of the old lock was proceeded with. The foundations, which were composed of blue lias concrete, were laid in the bed of gravel and sand uniformly underlying this district, as shown in the works at the new reservoirs of the East London Water Company, at Lee Bridge and Old Ford, and at the Victoria, West India, Commercial, and London Docks. This stratum permitted the percolation of water, emitting a strong odour of sulphuretted hydrogen, and evidently impregnated with iron, which was deposited in the form of hydrated oxide on exposure to the atmosphere.

The principal dimensions of the locks were: the Eastern lock, 96 ft. long by 18 ft. 6 in. wide, having the lower sill laid at the level of 10 ft. below, and the upper one 3 in. above, high-water mark. The Western lock was 90 ft. long by 16 ft. wide; the lower sill being laid at the level of 7 ft. 9 in. below high-water mark, and the upper one at the same level as in the other lock. The pier between the locks was 138 ft. long, 12 ft. wide, and 19 ft. high.

The walls and pier were of brickwork, faced with hard pavior stocks, set in Portland cement, and backed with concrete, hoop-iron bonds being introduced at every eighth course. The invert of the smaller lock was composed of Portland cement concrete; that of the larger lock was originally of the same material, but, owing to the percolation of water, a width of 6 ft. in the centre was of two half-brick rings set in cement.

The principal points of novelty were, the combined pointing sills and hollow quoins, both of cast-iron, and the sluices. The sills were each cast in one piece, and were of sufficient length to allow of the ends being firmly built into the lock walls, thus forming the foundation plate for the gate pivots. The arrangements were such, that each sill and pair of hollow quoins were placed in position and firmly bedded in less than two days. When the locks were sufficiently advanced, the gates, framed ready for fixing, were lowered entire, instead of being, as usual, erected piecemeal in the lock-pit—a tedious operation, necessarily performed after the lock-walls were built; whilst, by the plan adopted, the construction of the gates was entirely independent of the lock-work. The balance beams, anchor caps, foot sockets of the heel posts, and fender frames (of which there were four built into each lock wall), were all of cast iron.

The culverts and sluices were all placed in the pier between the locks. There were five culverts; one for filling and one for emptying each lock, and one for connecting the two locks. In consequence of the confined lateral space, those for the western lock had to be built above those for the eastern lock; the roof, or flooring, separating them, being formed of cast-iron plates. The sluices were, to a certain extent, self-acting. This was effected by making them somewhat in the form of a caisson, which worked perpendicularly and nearly watertight in a chamber. There were two valves in the caisson; one for emptying the chamber, or allowing the water to run off, and the other for filling, or allowing the water from the upper level to pass into the chamber. When it was required to raise or open the sluice, the former valve was opened, which released the water in the chamber, and left against the sluice the upward pressure due to the difference between the two levels (ordinarily 10 ft.), which tended to force it up. When the sluice was to be lowered, the water was generally at the same level on both sides, in which case it descended by its own weight; but should it be necessary to lower it against a pressure, the water from the upper level was allowed to run into the chamber, so as to produce a downward pressure. These sluices could be raised by one man in half a minute, and by their aid the larger lock could be filled or emptied in less than two minutes. They were designed and manufactured by Messrs. Lawrence, Brothers.

The wharf and towing-path walls were formed of headers of Kentish ragstone, backed with concrete. The material used for raising the towing-path was almost entirely obtained by dredging the main river, and consisted of gravel, mixed with a small proportion of peat and mud. This made a perfectly water-tight bank, without the use of puddle. On the opposite side of the navigation a new bank, 10 ft. in width at the top, with an inner or water slope of 2 to 1, and an outer slope of $1\frac{1}{2}$ to 1, was formed from side cutting. In the centre of this bank there was a puddle wall 6 ft. in width. By these means the navigation had been widened, so as to allow of a lay-by for barges along the whole length, and thus to afford available water frontage to a large area of land.

The stop gates at Pond Lane were constructed in order to allow the water to be drawn off at Old Ford Locks, without incurring the expense of a dam. They were 22 ft. in width, and the sill was laid at the level of 7 ft. 11 in. below the Lee Bridge headmark. Their construction was very similar to that of the Old Ford Locks, except that the cast-iron pointing sill formed nearly a square nosing to a brick sill.

A steam dredging machine was employed for deepening the river, the average cost of raising material being from 10d. to 11d. per cubic yard, according to the weight, including a "lead" of $1\frac{1}{2}$ mile, and allowing for wear and tear of machinery.

The total cost of the works was about £220,000, which amount included £4,000 for land, and £2,000 for plant, now being used on works higher up the river. They were designed and executed by Mr. Beardmore, M. Inst. C.E., assisted by the author, without the intervention of a contractor.

In the second part of the Paper it was argued that canals were still extensively useful, as a means of conveyance, and that they might be rendered more so by combination with railways. The returns of the Grand Junction Canal Company, which had to contend with the formidable opposition of the London and North Western Railway Company, gave an actual increase, from 1840 to 1856, of 262,942 tons per annum, or $28\frac{1}{2}$ per cent. Although this was liable to fluctuation from year to year, the average of each quinquennial period showed that the increase had been gradual and progressive. This result was in some degree due to a considerable reduction in the tolls, and also to the development of the resources of the country due to railways; so that canals were now actually profiting by that which in the first instance threatened to annihilate them. The traffic on the River Lee Navigation, which had to compete with the Eastern Counties Railway for its whole length, had steadily increased during the years 1851-6, 25 per cent. in tonnage, and about 50 per cent. in receipts, notwithstanding that the tolls had been considerably raised.

As an example of a different class, namely, of a canal working in conjunction with a railway, the Trent and Mersey system, worked by the North Staffordshire Railway Company, was cited; and it was stated that, during the ten years from 1846 to 1856, the tonnage must have increased 40 per cent. Under this head the enormous amount of coal distributed by the Regent's Canal, from the Great Northern Railway, was also quoted. It appeared that, in 1857, the quantity of coal passing upward from the River Thames and Great Northern Railway was 554,788 tons, whilst that passing downwards from the Grand Junction was only 4,997 tons. The former amount included 156,927 tons from the Great Northern Railway. Thus were combined the rapidity of transit of the railway, and the facility of distribution by water communication by means of the Canal and the Thames.

As to the system of management on canals, it was suggested that interchange of traffic should be encouraged, by the adoption of a uniform system of tonnage rates per mile; that there should be unanimity of purpose and cordiality of feeling; that the idea of competition between canals and railways should be abandoned; and that they should mutually assist and be auxiliary to each other, rather than antagonistic, as had too frequently been the case. The extensive establishments at Bull's Bridge, on the Grand Junction Canal, for the Great Western Railway, and at Maiden Lane, on the Regent's Canal, for the Great Northern Railway, and the arrangements of the South Yorkshire Railway and River Dun Company, were quoted. It was also suggested that it might be of advantage to the companies to encourage the establishment of manufactories on the canal banks.

Steam tugs were gradually coming into favour for working the traffic. The difficulty had hitherto been to use vessels of sufficient power, without injuring the banks. This had, to a certain extent, been overcome on the Regent's Canal, where the tug, constructed by Mr. Inshaw, of Birmingham, had a screw on each side, the one being right, the other left handed, so that the wash from the one tended to neutralise that from the other. On the Aire and Calder navigation four steam towing barges were employed for the goods traffic, and a different class of towing barge for minerals. Tugs might be employed advantageously on long levels, say of over 2 miles in length; but where the traffic was large, they should not be allowed to pass through the locks, and on shorter lengths horses should continue to be used. Time-bills should be adopted, so that steam might be continuously employed. The speed should not exceed from 4 to 5 miles per hour, as, at higher rates, the resistance of the water would be so great as to require an unnecessarily large expenditure of power, and the wave created would tend to destroy the banks.

April 13, 1858.

Isambard K. Brunel, Esq., Vice-President, in the Chair.

The Paper read was, an "Investigation into the Theory and Practice of Hydraulic Mortar, as made on the New Works of the London Dock Company, 1856-57." By Mr. G. Robertson, Assoc. Inst. C.E.

The theoretical points treated of in the Paper were those connected with the calcination and slaking of blue lias lime; the action of silica in protecting it from solubility; the setting of mortar, and its subsequent absorption of carbonic acid.

The second, or practical part, gave a detailed account of the method and cost of manufacturing mortar at the London Docks, as well as the effect of grinding on its strength and density.

It was observed that many of the contradictory statements of writers on this subject appeared to have arisen from a misconception of the word "hydraulic," which ought not to be applied to limes, merely because they set under water (as many soluble substances would do the same), but should be reserved for those which increased in hardness from the action of the water itself.

The chemical effect of calcination on blue lias was examined, and an account given of an experiment made on a large scale to check the value of an analysis in predicting the yield of any limestone. According to calculation, 38·35 per cent. of water and carbonic acid should have been driven off in the kiln; but, on burning 145 tons of stone, and weighing the lime produced, it was found that as much as 40·63 per cent. had been driven off, a difference, however, of only 2·28 per cent., due to a larger quantity of moisture in the mass than in the small specimen. The chemistry of slaking, or the formation of hydrate of lime, and the necessity for it, were next examined, and it was shown that when lias lime was slaked in such a manner as to form the best and strongest mortar, it increased 31 per cent. in weight, or 8 per cent. more than the water required to form a hydrate with the oxide of calcium found by analysis in the stone.

As lime was soluble in water, it must be protected either naturally or artificially, before it could be used in hydraulic works. The nature of this protection had been the subject of many theories; its degree distinguished a lime from

a cement, and gave rise to the phenomena peculiar to each. Clay, or silicate of alumina, being found in all hydraulic limes, silica and alumina were examined, at length, and the peculiar value of each was pointed out; one as an active, the other as a passive agent, in indurating limes under water. The Author was of opinion that the action of silica did not commence, to any extent, until the completion of the hydration of the lime. This theory was closely examined and it was also shown that a certain quantity of free water was necessary to promote the action of silica in forming double silicates of lime and alumina. In nature, this combination took place in the minerals of the zeolite family, of which hydraulic mortar was but an imperfect member. The phenomena exhibited, both by limes and by cements, were examined by these theories, and appeared to confirm them in a remarkable manner. The true time, both theoretically and practically, for mixing hydraulic lime as mortar, was, therefore, at the point when hydration was perfectly over, and before the formation of silicates; "blowing" being avoided on the one hand, and friability on the other.

The different methods of slaking lias lime were then examined, and that of spontaneous extinction shown to be almost impracticable on large works, even were it desirable, which it was not. When slaked with the quantity of water practically found to make the strongest mortar, no difference was found to exist, on the large scale, between slaking in the ordinary way and by immersion. After trying about 400 tons, the latter system, proving about 50 per cent. dearer, was abandoned.

The next point treated of was the first hardening, or "set," which took place when mortar was permitted to stand undisturbed. This was proved to be due, not to desiccation, but to a mechanical absorption of the water of mixture by the capillary attraction of the pores of the lime, hastened or permitted, as the case might be, by evaporation, or by chemical agency. With immersed mortar this set was delayed until the imprisoning cells became a partial silicate of lime. Four modifications of setting were named; 1st, in slaked rich lime, where the action could not be chemical, but must be mechanical; 2nd, in quick rich lime, where setting was hastened by a portion of the water of mixture being taken up chemically in forming hydrate of lime; 3rd, in slaked hydraulic lime, where the formation of insoluble silicates rendered setting possible under water; 4th, in cements, or hydraulic limes used quick, where the set under water was not only rendered possible by the formation of the same silicates, but also hastened by the formation of hydrate of lime. The third case was examined at length, as the most applicable to the subject of the Paper. The danger of "blowing," which resulted, more or less, when quick lime was used, was particularly pointed out, and instances given of the gradual decline of that system.

After alluding to the use of pozzuolana, the Paper proceeded to treat of the ultimate hardness caused by the absorption, from air or water, of carbonic acid, and gave the distances it was found, from practice, to have penetrated into various limes and cements, with its rate of travel. It was ascertained by experiment that the penetration varied inversely with the strength of the silicate in the mortar; and also, that limestones gave off carbonic acid to mortar in contact with them.

Allusion was then made to various substances which had at different times been deemed hydraulic. Alumina was valuable only as a cheap and convenient carrier of silica, to present it in a useful form to the hydrate of lime, and to assist in the formation of double silicates. The hydraulic value of the roasted ores of manganese, or of iron, of slags of all kinds, of magnesia and of ashes, was traced entirely to the quantity of silica present in them, in a useful form. Considerable attention had been paid to the hydraulic pretensions of iron, whether as a metal or an oxide, instances of both being given; and the conclusion arrived at that it was of doubtful advantage in any form, and in some it was positively injurious.

In the second portion of the Paper a minute account was given of the manufacture of the mortar for the London Dock extension. Except for top work, blue lias from Lyme Regis was almost entirely used. It was burnt in two kilns erected by the Company, each capable of holding 100 tons, the pair being able to keep up a daily supply of above 20 tons of quick lime. 100 tons of stone yielded 59·37 tons of lime, sufficient for 1,583 bushels of ground lime, 3,063 bushels of slacked lime, 231½ cubic yards of first-class mortar, and 262½ cubic yards of second-class mortar. Details of the price of burning, slaking, grinding, and all other stages in the manufacture of mortar and lime for concrete, were given, both in the Paper, and more elaborately in the Appendix.

In slaking, the quick lime was spread out in a layer 6 in. thick; 74 gallons of water to the ton were then thrown over it as evenly as possible, and the decrepitating lime was shovelled into heaps, and covered with sand till required.

The proportions of the mortar used at different heights in the work were given, with the contraction from the dry materials after different periods of grinding. Two Tables were exhibited, showing the effect of grinding, by which it appeared that the adhesion of the mortar was increased up to about six hundred revolutions of the pans, after which it was injured by the gradual formation of silicates, with their accompanying result—friability. Up to the same point the density of mortar was also increased; but, if the grinding was long continued, the mortar began to swell, with a puffy look and feel, caused by the water beaten up with it.

In conclusion, the paramount importance of good hydraulic mortar was urged, and it was hoped that the Paper would lead to a closer investigation of the subject.

At the monthly ballot the following candidates were balloted for and duly elected:—Messrs. A. Retortillo and R. Sinclair, as Members; and Messrs. L. Clark, W. B. Hawkins, A. James, W. Smith, and A. Stein, as Associates.

April 20, 1858.

Joseph Locke, Esq., President, in the Chair.

The paper read was Description of the Iron Viaducts erected across the Tidal Estuaries of the Rivers Kent and Leven, in Morecambe Bay, for the Ulverstone and Lancaster Railway. By Mr. James Brunlees, M. Inst. C.E.

This Paper formed a sequel to one read in the session 1854-55, on the construction of the sea embankments across the same estuaries, which were each about 1½ miles in width, the viaducts being the necessary openings for the tidal channels. The superficial stratum of these estuaries was ascertained, by borings, to be sea-sand for a depth of 70 ft. A series of careful experiments was instituted, to determine the bearing power of the sand, various forms of piles and discs being sunk and weighted, and their subsidence observed. Simultaneously with the weighting, a constant vibratory motion was communicated to the piles, thereby rendering the conditions of the test as analogous as possible to the work the piles would ultimately have to perform. The average result proved the sustaining power of the sand to be about 5 tons per square foot. As it was considered desirable that each bearing pile should carry, at least, 20 tons, the discs were made 2 ft. 6 in. in diameter, giving an area of 4·86 square feet, or 24·30 tons sustaining power. The discs of the raking piles, however, were only 18 in. in diameter. In the four-pile piers there was an area in the discs of 16·30 square feet, and as all the piles were intimately bound together by strong walings and transverse ties, the sustaining power of each pier exceeded 80 tons, without taking into account the firm bearing the walings had upon the rubble stone weirs, introduced to prevent the scour of the channels. Experiments were tried upon various forms of piles, including the bell-mouth, to be filled with concrete; but the form adopted, as most satisfactory in every respect, was a plain disc, cast on the hollow column, with an orifice 3 in. in diameter in the centre.

With the exception of those of a few piers at each end, the whole of the piles were sunk to a depth of 20 ft. by hydraulic power, applied in the following manner. The hole in the centre of the disc received the lower end of a pipe 2 in. diameter, which, extending up the hollow pile, was connected, by a flexible hose, with a donkey engine and pumps, placed on a pontoon moored by the site of the piers. The water was forced by these appliances down the pipe, and an alternating rotatory motion being communicated to the pile, the sand beneath was loosened by ribs, or cutters cast on the lower surface of the disc, and was readily washed or blown away by the water, thus causing the pile to sink rapidly. The piles were kept in position by means of the slide block apparatus of a piling machine, and the sinking was much facilitated by keeping a considerable part of the weight hanging on the piling engine, thus preventing any irregularity of sinking, or undue strain on the pumps. In this manner two piles were generally put down from each pontoon during ebb tide. Each pile was finally driven down 2 in., with a heavy "tup," to consolidate the loosened sand. The timber-guide piles in the approaches to the drawbridge, consisting of balks 14 in. square, were fitted with cast-iron sockets and discs, and sunk by the same process, and with as much facility as the hollow iron cylinders. There can be no doubt, that this simple and economical mode of sinking hollow piles would be equally efficacious in the case of much larger cylinders than those here described, the interior being subsequently filled with concrete, or masonry in the usual manner.

The different parts of the viaducts were designed to facilitate the necessary additions when a double line of way was demanded, one and two columns being required in each pier alternately to complete the design. The piles and columns were of cast iron, 10 in. external, and 8½ in. internal diameter. The piles were sunk to a depth of 20 ft. in the sands, and the longest column was 22 ft. above the walings. The roadway was formed of longitudinal timbers, laid on open planking 3 in. in thickness, supported by three continuous lattice bearing girders, and one light outside girder. In the double way, one line of bearing girders and one outside girder would be necessary in addition. The girders were braced transversely over each pier, and at three points in each bay. They were made in sheds near the sites, and, after being floated on the pontoons to the viaducts, were raised and seated, and then bolted together, allowance being made for contraction and expansion. These girders were tested in 30 feet lengths, up to a load of 30 tons in the centre, which produced a deflection of half an inch. They were loaded up to 1½ tons per lineal foot *in situ*, where the girders were continuous, with no perceptible deflection, but those over the end openings went down one eighth of an inch, rising again on the removal of the load. The piles were effectually defended from the scour of the tides by weirs of rubble stone.

The length of the Leven viaduct was 1,563 ft. In its construction 395 tons of wrought, and 438 tons of cast iron, were used. The total cost, including abutments, drawbridge, and weirs, was £18,604 for a single line, and the whole structure was completed in thirteen months. The Kent viaduct was 1,566 ft. in length. In its construction, 406 tons of wrought and 368 tons of cast iron were used. The total cost for a single line was £15,056, and the whole structure was completed in eight months. The cost of the Leven viaduct, when completed for a double line of way, would be £24,361, or £46 15s. per lineal yard. The Kent viaduct, when completed, would cost £20,813, or £39 17s. per lineal yard.

The President directed attention to some Further observations, explanatory of former remarks, on the subject of submerging Telegraphic Cables," by Professor Airy, which were read.

The importance of the subject and the urgency of time were pleaded as excuses for reverting to this matter out of due order; and the desire to arrive at accurate, instead of only approximate results, had induced further experiments and new records of those results.

It had been stated that the terminal velocity of the cable falling through water would not much exceed 3 ft. per second; this led to more accurate in-

vestigation, omitting no part of the resistance of the water, and the general result was—that for safe circumstances, when the angle of inclination of the cable, on leaving the ship, approached very near to the limiting or critical angle, the views expressed by Mr. Gravatt, in a former discussion, were correct; and the numbers given by Professor Airy, in a former table, were considerably too large; and for dangerous circumstances, when the cable, on leaving the ship, was very little inclined to the horizon, the numbers in the former table were very nearly correct. Thus, the inequality in the amount of tension of the cable depending on the angle of its leaving the ship, was even greater than had been supposed; and the necessity for the severest caution in regulating the angle of delivery of the cable, was even more urgent than had been stated.

In order to present the results in the clearest form, a new table was prepared, on the assumption that the velocity of the ship was double the terminal velocity of the cable, when allowed to fall freely in the water. The unit of measure was, in all cases, the depth of the sea. The unit of tension was, in all cases, the weight of a piece of cable whose length was equal to the depth of the sea, as weighed in sea water. So that if, for example, the tension was expressed as 2·5, and the sea was 2 miles deep, the meaning was that the tension was the weight of 5 miles of cable, as weighed in water.

Angle made by the Cable with the Horizon on Leaving the Ship.	Tension at the point of leaving the Ship.	Length of suspended Cable.	Corresponding horizontal extent.	Difference, or stray length necessary for the slope of the suspended Cable.
2° 52′	747·23	39·326	39·311	0·015
5 43	173·62	19·303	19·267	0·036
8 34	71·33	12·616	12·564	0·052
11 22	36·78	9·254	9·184	0·070
14 9	21·36	7·222	7·134	0·088
16 53	13·26	5·849	5·742	0·107
19 32	8·50	4·843	4·716	0·127
22 6	5·46	4·055	3·905	0·150
24 30	3·32	3·376	3·200	0·176
25 37	2·39	3·031	2·839	0·192
26 34 Limiting Angle.	0·53	2·236	2·000	0·236

The table would show the amount of tension in special circumstances, as well as the increase of tension, or amount of danger which might be introduced by mismanagement of the delivering apparatus. Thus, supposing the delivery to have been effected with a stray length of 0·236, and with a tension of only 0·53, if, by inattention to the mechanism, the delivery was impeded for a time, so that the stray length was diminished by 0·166, the stray length would be reduced to 0·070, implying that the tension was increased from 0·53 to 36·78; the only indication of this being that the angle of inclination of the cable had been reduced from 26° 34′ to 11° 22′. A vigilant watch on the angle of inclination of the cable was, therefore, of the utmost importance for its safety; and the mechanical arrangements should exhibit vividly to the superintendent the slope of the cable on leaving the ship.

As to the general characteristics of the curve formed by the cable,—

In no case whatever was the convexity of the curve upwards.

The speed of delivery being supposed as equal to the ship's speed:

Dividing the terminal velocity of cable, when falling freely in water, by the ship's velocity, and finding the angle, of which this quotient was the trigonometrical tangent, gave the critical, or limiting angle.

The lower part of the curve approached in form to the common catenary, but the inclination of the upper part to the horizon never exceeded the limiting angle. If the tension became great, the curve was nearly the lower part of a catenary of large dimensions.

When the tension at the bottom was absolutely nothing, the form of the cable would be absolutely a straight line lying at the limiting angle, with only a small tension at the point where the cable quitted the ship.

In considering the speed of delivery, when it was greater than the velocity of the ship, it was observed, that as the speed of delivery was augmented, the tension was diminished, until the proportion of the speed of delivery to the ship's speed became the same as the proportion of radius to the course of the limiting angle. There was, then, no sensible tension in any part of the cable, which descended at the limiting angle, but depositing itself in folds on the bottom. If the speed of delivery was further augmented, the cable would descend in a serpentine form.

In viewing the practical inferences, it was observed, that when the cable was weak and the sea deep, the cable should be delivered rather faster than the ship's speed, by which means the cable could be safely deposited, so long as the ship continued in motion. If, however, the cable was strong, and the sea not deep, the velocity of the delivery need not much exceed the ship's speed, but the angle of inclination should not be less than the limiting angle.

In case of the ship's motion being stopped, and the delivery of the cable being at the same time arrested, the tension of the cable would be much increased. If this occurred in deep water, the cable would be delivered out liberally, or the ship should be backed until the cable assumed a position not much inclined to be vertical. By this precaution, little or no length of cable would be lost, as when the ship again advanced, without paying out any cable for a short time, the depending cable would be quickly taken up into its former position, without any irregularity at the bottom. The minimum tension, when the ship was stationary, was taken as 1·00.

The suppositions adopted in the preceding investigation were thus alluded to:

It was known, that with velocities so small as that of the cable descending in water, the resistance was expressed by the sum of two terms; one depending simply on the velocity, and the other depending on the square of the velocity, and when the velocity was very small the former term alone need be considered, which had been the case in the present investigation. The results obtained corresponded almost exactly with those due to a rather greater velocity of the ship.

The cable was subject not only to motion transverse to its length, but also to a longitudinal motion and to the consequent considerable friction. No data being known for estimating this, it had been assumed as equal to the lateral resistance, at equal speeds. Allowing for these, it was believed that the results of the theory promulgated were perfectly accurate.

It had been stated that the strength of the Atlantic Cable and its weight in water were such that it would bear a length of about 4½ miles, or, as expressed in terms of the depth of the sea, about 2·00. Consequently, the mode of delivery must be such, that the tension could never exceed the value 2·00. This tension occurred so near to the limiting angle, that it would not be safe to trust to the delivery at the limiting angle, with a velocity equal to the ship's speed; but the delivery must be more rapid. Consequently, the length of cable to be provided must be greater than the run of the ship. From all these considerations it appeared probable that the practicability of laying down the cable in the present year might depend principally upon the numerical value of the element, hitherto not ascertained, of the coefficient of friction for a cable sliding endways through the water.

In the discussion upon these observations, it was admitted that it was only by mathematical investigation that a correct conclusion could be arrived at on this important question. The Paper by Messrs. Longridge and Brooks, which was read at the meeting of February 10th, was based upon such an examination, the formulæ and calculations being given *in extenso* in an appendix. It was desirable that the mode of obtaining the results now recorded should also be placed before the members, in order that a comparison might be instituted, as it was believed that the difference in the conclusions could only arise from the neglect, in one of them, of some of the conditions of the problem.

It was remarked that, in the Paper before alluded to, the coefficient of longitudinal friction, which was material, as it afforded the only means of diminishing the tension, had been introduced as one of the forces affecting the result. These forces were: first, the tension at the ship; second, the weight of the cable; third, the resistance of the water, which could be resolved into two forces, one at right angles, and the other parallel, to the cable, and acting by friction; and lastly, the horizontal tension at the bottom. The numerical value of the coefficient of longitudinal friction had been derived from the experiments of Colonel Beaufoy, and was probably somewhat less than what it would actually be in the case of the cable. The amount of relief to be obtained by the introduction of that coefficient would be so small, unless the ship was progressing at a very high velocity, that, practically, it was not a desirable method of diminishing the effect of the tension.

It was presumed that the last column of figures given in the Table, which was stated to be the stray length, represented the waste when paying out at the angles given in the first column, being the difference between the length of cable suspended and the horizontal length. The tangent of the limiting angle was stated to be equal to the ratio between the terminal velocity of the cable descending vertically and the velocity of the ship, when they were respectively 3 and 6 ft. per second, and the cable was being paid out at the same rate as the ship was advancing. But the tangent of 26° 34′ was just one half, so that the Table must have been calculated upon the supposition that the vessel was progressing, and the cable was being paid out, both at the rate of 6 ft. per second. The angle 26° 34′ did not differ materially from that given by Messrs. Longridge and Brooks; but it was not possible to imagine that any circumstance could arise in practice by which this angle could be reduced to 2° 5′, unless the rate of paying out was below that of the velocity of the ship, or the paying out was altogether stopped, in either of which cases the result must be to break the cable.

It had been previously shown that it was possible to lay the cable without tension at the bottom, and, at the same time, without waste or slack; and a formula had been given for calculating the amount of tension requisite to insure that result. It was argued that, if there was no tension at the bottom, the cable must descend in a straight line; and there were no forces in action to cause the cable to assume the wavy form in its descent, as represented in one of the diagrams.

It had been stated that the resistance of the water consisted of two parts, one of which was as the velocity simply, whilst the other was as the square of the velocity. The latter, which was the more important, and which was believed to be very nearly correct, appeared to have been neglected in the present inquiry.

It was remarked, that the views contained in the communication could scarcely be considered applicable to the submerging of telegraphic cables.

It was urged that the tabular statement could not be practically relied upon. The mathematical deductions might be accurate, but the premises could not be correct, and therefore the deductions were valueless. There were certain obvious inconsistencies in the Table itself, and the principle upon which it appeared to be constructed would lead to results that were irreconcilable with fact and experience, especially when the limiting angle approached the vertical, as then the tension would appear to be 0·; whereas it must incontestably be represented by 1·: that is to say, the weight of a length of cable (weighed in water) equal to the depth of the sea.

A series of diagrams exhibited the cable under a variety of conditions when being submerged. These were explained; and it was shown that the general character of the curve was the hyperbolic, much resembling a catenary at the bottom, and going off towards an inclined asymptote at its upper extremity. The causes of irregularity in depositing, and the nature of these irregularities, were examined and explained.

The whole question of submerging a cable was a problem of a most complicated nature, far exceeding the complication of the motions of a planetary

body through the heavens. The motions of any given point on the cable could only be expressed in terms of a certain curve yet unknown, which must be assumed to travel on, while the point assumed different positions on the curve. The forces in action were: a certain tension of the curve, with a certain inclination on that part of the curve which was above the point in question; a different tension, with a different inclination on the part of the curve below it; the weight of that portion of the cable; the resistance to the lateral motion; and the resistance to the longitudinal motion: all these must be expressed by means of a curve yet unknown. The investigation was very abstruse; and if it had been anticipated that the calculations would have been asked for, they would have been prepared; they would now be put into order for presentation, and be laid before the Institution.

It would be observed that the Table was meant to apply to a very different case from that which had been assumed, and it was contended that to the circumstances described it was strictly applicable, as would be seen from the calculations, the details of which would be transmitted.

May 4, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

The Paper read was On Public Works in the Bengal Presidency, by Major-General Tremenheere, Assoc. Inst. C.E.

The author traced the condition of India, with respect to public works, from the earliest period to the present time; and showed that, neither during the Hindoo nor the Mahommedan dynasties had any real progress been made. On the main lines of communication the roads were incomplete, being neither raised above the general level, nor drained, nor metalled; the only traces of the roads still remaining were detached rows of trees, denoting their general direction, and some ancient unskilfully constructed bridges. The ancient caravanserais, which were large enclosures for the convenience and shelter of travellers, and the protection of merchandise, were the best monuments of attention to the public convenience during the native rule.

Considerable attention had been, from an early period, paid to works for the irrigation of the land, which were of Hindoo origin. Reservoirs of large extent, or tanks for collecting a large body of water in the rainy seasons, were, at all times, a principal concern of the native government, in the south and western portions of Hindoostan; but as nearly the whole of the revenues of the sovereign depended upon the produce of the soil, works of this nature could hardly be entirely ascribed to a desire to promote the public good.

About the middle of the fourteenth century, in the Mahommedan period, canals were first undertaken in the North Western province. The object of the Emperor Feroz, however, was more to conduct water to one of his favourite hunting grounds at Hissar, for the convenience of his retinue, than for the benefit of the husbandmen; and nearly two centuries afterwards, another of the emperors, Shah Jehan, constructed a branch from the old canal, to supply water for the fountains of his palace, and to adorn the streets of the rising city which in the year 1626 he was erecting on the site of ancient Delhi. The origin of the eastern Jumna canal, in the same reign, was in connection with the palace of Ranus, which was at its terminus opposite to Delhi. All these canals had long fallen into disuse, and were in an utterly neglected and abandoned state, when the English assumed the government of the country.

The personal experience of the author extended over the past 30 years, and the Paper was confined to an account only of the modern public works in the Bengal presidency, to which he had been attached. He described the physical features of Bengal and of the North Western provinces, and showed how the relative positions of the Himalaya mountains and of the sea affected the climate, and the rain-fall in the upper and lower parts of the country necessitated in each engineering works of a totally different character for the improvement of agriculture and the benefit of the people. Thus the bunds, or embankments, of the Bengal rivers were designed to protect the land from destructive inundations, whilst the canals of the North Western provinces were intended to save the country from the effects of drought.

The system of embankments was founded on erroneous views, and remedial measures were now most difficult of accomplishment. The effective restoration of the canals of the North Western provinces was then fully described, and the advantages which had been permanently secured to the people were descanted upon. The results had been, up to the year 1852, a surplus of net revenue, over expenditure, of £299,616.

Encouraged by this financial result, the British government undertook the formation of the Ganges canal, a work of dimensions and extent far exceeding any other of similar character in any quarter of the world. The design and the execution were due to the skill and energy of Sir Proby Cautly, C.B. The length of navigable channel, and for purposes of irrigation, would be eventually 890 miles, of which 350 miles were already open, from the source near Hurdwar to the station of Cawnpore. The breadth at the bottom, at starting, was 140 ft. and the depth 8 ft.; these dimensions were gradually reduced as the waters are drawn off for irrigation. The outlay, up to 1854, had been £700,000. The expected return was a clear profit of seven per cent. on the outlay, and as much more from the permanent increase in the rental of the land. Some of the works near the head of this canal were of great professional interest. The hill torrents which intersected its course were of great breadth and velocity. They sometimes crossed the canal on the same level, and sometimes below it. In two localities the torrents themselves were safely conveyed over the canal, on aqueducts of 200 ft. and 300 ft. in breadth.

The workshops and the Civil Engineering College at Roorkee were then shortly described; and the measures which had been adopted to extend the benefits of artificial irrigation to the districts of Rohilcund, to the Deyrah Dheere, in Ajmore, and in the Punjaub.

The facilities for river navigation in India were then adverted to, and the necessity of limiting the draft of river steamers to a maximum of 2 ft.

With regard to ports and harbours there had been no works, except at Kurruchee, where some attention had been recently given to the subject.

The state of the existing roads and bridges was then dwelt on, and the difficulties which had interfered with the construction of the permanent bridges, many of which were wanting, at the present time, to complete the only road of military communication between the seat of government and its distant provinces. Between Calcutta and Kurnaul the road itself was excellent, and these important breaks in its continuity were in course of being supplied; but the progress was very slow. From Kurnaul to the Sutledge, and to Lahore, and from thence to Peshawur, the workmen were, till lately, employed on the earthwork alone, and the period of completion had been indefinitely deferred by the late disturbances.

The district, or branch, roads had been much improved of late years, since the proceeds of the ferry dues had been set aside for their formation and maintenance. An additional assessment of one per cent. had also been made on the land on the same account, but in the application of these funds there had been a great deficiency of professional knowledge, which was not available in the country.

In the opinion of the author, the best method of facilitating and increasing the traffic of the fertile districts lying to the north and south of the Ganges would be, by the construction of railways rather than common roads; and he saw no reason why, in a country so level and so generally free from engineering difficulties, such railways should not be made at a most moderate cost.

The subject of railways generally was then adverted to, and the necessity for fully developing a complete system for India, of which those lines already commenced, or authorized, were but the groundwork of what were urgently necessary to bring out the enormous resources of that vast empire. These resources were not yet sufficiently known to capitalists, and to the capabilities of the country the assistance of European science had never been applied. It was hoped that, by the efforts now making to carry out the plans so energetically proposed by Sir Macdonald Stephenson, the great end would be attained.

One great deficiency in India was the almost total absence of trustworthy and well-instructed European subordinate agents, which was the first difficulty to be encountered in the prosecution of any enterprise, or the execution of any great works in India. The author proposed that this defect should be remedied by training the children of the European soldiers in India in industrial establishments, to be formed in the Himalayas; and he showed that thousands of English soldiers continually perished in India without adding to that very element in the settled population of the country which recent events had shown to be so much required. Those children who were born in the barracks died in the plains, in the ratio of four out of every five. There were at this moment 900 children of soldiers at the station of Dum Dum, near Calcutta, most of whom might be saved, and be turned into useful overseers, trained agriculturists, and teachers of various branches of skilled industry, if they could be removed to the hills. The author also proposed, with a view to increase the European population, and the settling in India of the lower and middle classes, that the permission for the marriage of soldiers going to India should be extended beyond its present limit of 12 per cent.

In conclusion, allusion was made to the establishment of the electric telegraph by Sir W. O'Shaughnessy, which had been highly useful as an engine of government, though it appeared that the natives had hitherto regarded it with indifference.

ROYAL SCOTTISH SOCIETY OF ARTS.

Monday, January 25th, 1858.

Edward Sang, Esq., President, in the Chair.

The following communications were made:—

1. *On an Improved Stove for Heating Apartments, Greenhouses, &c.*, with a Drawing. By James Stark, M.D., F.R.S.E., V.P.—Dr. Stark described his improved stove for heating apartments and greenhouses. The stove consisted of a cylinder of sheet-iron, with an inner casing of cast-metal rising the height of the top of the door, and within which alone the fuel was burned. The whole fireplace for the coals was below the opening of the door, while the cylinder rose high above the door and terminated in a flat top, on which was placed an iron plate containing water. A flue, provided with a damper, passed off at the back of the stove, close under the flat top. The cast-iron box containing the ash-pan was made close, so that the quantity of air which was admitted to the fuel might be under perfect regulation. It was stated that the special advantages of this form of stove were the absence of the usual burnt smell which prevails in apartments heated by stoves; the capability of regulating with the greatest accuracy the temperature of the apartment; the ease with which the stove was heated; the very great economy in fuel, as it only required common Scotch dross of any kind; the cheapness of the stove, and its non-liability to get out of order or require repairs. The author stated that he had used the stove for a period of three years, and that an 8-inch stove 30 in. high, had kept an apartment 18 by 14 ft. and 13 ft. high at a steady temperature of 63° during all the days when a fire was requisite, and that the average amount of fuel consumed annually was only one-and-a-half tons of common Scotch dross—value about 7s. 6d. The author added some general remarks on heating and ventilating apartments.—Referred to a committee.

2. *On Explosions of Carburetted Hydrogen in Coal Mines, with the points to which we may look for their Radical Cure.* By Henry Cadell, Esq., Grange, Bo'ness. Diagrams were exhibited.—The appalling accidents which occur every now and then at intervals not very distant, Mr. Cadell stated were subject of much painful interest, and for a number of years have been inquired into by Committees of both Houses of Parliament, but without any decided effect in remedying the evil. He stated that much ingenuity had been shown in the improvement of ventilation of mines, and many appliances were adopted for driving or drawing air through the mines; and, from the evidence given before the Committees, it appears that in many cases these

might be said to be carried to the verge of their capability. The various safety lamps in use, the principal being that by Sir Humphrey Davy, had been the means of bringing into operation mines which, without such appliances, would have been altogether unworkable; but it is allowed that since the introduction of these, accidents by explosion had rather increased than diminished, and as there were many contingencies by which these lamps might be injured, or made to communicate the flame to the explosive mixture, there could be no safety from explosions so long as these lamps were in the hands of hundreds of workmen; and he considered the only preventive was by keeping the workings at all times so aired as to be far removed from the explosive point, reserving safety lamps for special use in heading rooms and levels going before the body of the workings. In order to effect this in many workings, one of two things is requisite, so as to render the ventilation so complete as to dispense with safety lamps in the regular workings—either more shafts must be sunk, or a system of working adopted which may effect the same object; and as the former is frequently subject of much difficulty, it is to the latter that he directed particular attention. The general methods of working coal may be classed under three systems—diagrams of which he exhibited—viz., 1. The pillar and room working, where rooms or excavations of from 3 to 6 yards wide are cut, leaving pillars of the coal for the permanent support of the superincumbent strata. 2. The panel wall system, where narrow excavations or rooms are made, leaving large panel-shaped pillars, which are afterwards partially taken out. And 3. The long-wall system, where the whole coal is taken away progressively, roads being formed by removing a part of the roof or pavement, the superincumbent strata in this case settling down gradually as the workings progress, leaving a clear space along the face of the coal. In the two first-named methods, there is a great face of coal exposed for the giving out of carburetted hydrogen, while a large open area is left for the gases to accumulate: while, in the latter, or long-wall system, there is the smallest amount of coal-face exposed, and, from the strata settling down as the workings progress, there is the smallest space left for the accumulation of gases; and the air-course being along the faces, which are nearly in a line, is short and direct, as compared with the other modes of working. He believed that what had been said would meet with little direct opposition, and found that, so far, these views were corroborated by the testimony of different engineers, at least for the purposes of general ventilation, and instanced the evidence given before a Committee of the House of Commons by Mr. Wynne and Mr. Landale, and the opinion of Hedley, in his book upon the ventilation of mines. The principal obstacles to the general introduction of this system are its alleged expense and apparent difficulty in high and clean seams; but these are matters more in idea than in practice, as in some parts they have been successfully overcome, and, when properly introduced, the long-wall system has generally been found preferable to the other modes of working, and has gradually been gaining ground. He concluded by repeating that what is to be looked to for safety from explosions, is a *ventilation sufficient to keep the workings at all times remote from the explosive point*; and with this view, where they are fiery and extensive, either more shafts should be sunk, or a method of working adopted which shall render easier, and thereby improve, ventilation, and that such is to be found in the long-wall system of working.

Monday, February 8, 1858.
Professor C. Piazzi Smyth, in the Chair.

1. *On an Improved Method of Graduating Hydrometers.* By Professor Elliot, of Queen's College, Liverpool.

2. *Description of a Check Grieve for Coal Sales, Registering, by means of Machinery to which he has no Access, the Weight of Coals sold by the Salesman.* By Mr. William Johnston, mineral manager, Carron Company, Falkirk. A model was exhibited. This machine is intended to be a check on the coal sales, and will prevent any suspicion between the salesman and his employer. It is simple, and easily understood. It consists of a disk in front with numbers engraved on the outer edge, with a pointer which is connected to two typed wheels, which are enclosed within a cover, where only a small opening is left in the cover for the salesman to put the ticket he is about to stamp into one of the typed wheels; and when he prints the required number of cwts. on the carter's ticket, the other typed wheel is at the same time registering the same number of cwts. on a strip of paper that the salesman has no access to, so that his employer at any time can compare the weight registered by the machine with the weight written in the sale books. The inventor stated that this machine, by a slight alteration, could be made to be useful in large drapery establishments for receipting and registering the sales of goods.—Referred to a committee.

Monday, 22nd February, 1858.
Edward Sang, Esq., President, in the Chair.

The following communications were made:—

1. *An Improved Cottage Window-Frame.* By the Hon. Lord Murray. Communicated by Professor C. Piazzi Smyth, V.P.

2. *On Photographical Illustrations for Books.* By Professor C. Piazzi Smyth, V.P. Specimens and apparatus were exhibited.—After alluding to various past attempts, attended with more or less success, to produce either direct or indirect copies of photographs for publication, the author referred to the illustration of his recent work on "Teneriffe," published by Mr. Lovell Reeve, of London, as an example of a large impression of a book illustrated with pure photographs. The requisite number of copies had been procured in this case by adopting the principle of printing from *secondary* negatives, so that several printers could be employed at once on the same plate. Further advantages had followed from this method, for the second negatives could be made to give much more intense pictures than the first; and in one instance the original picture had been an opaque positive, backed up with black varnish, and as such, generally supposed incapable of being multiplied. Its repetitions, however, produced by a process which the author described at length, form Plate 18 of the book in question. If there existed still any difficulty in supplying the public with copies of the work as fast as they were ordered, Mr. Lovell Reeve had reported that the difficulty was chiefly in getting experienced mounters, each photograph having to be pasted on a plate card, and each book having forty such mountings. This is, however, a trouble which must yield in time, if the public only approve of photographic illustrations; and in such case a new and suitable branch of industry will be opened up to the ill-paid class of seamstresses in large towns.

3. *Description of an Improved Registering Frame for Printing Chromo-Lithographic Plates.* By Mr. Robert Burn, Engineer, Edinburgh. Specimens were exhibited.

Monday, 8th March, 1858.
James Stark, M.D., F.R.S.S., Vice-President, in the Chair.

The following communications were made:—

1. Mr. Sang, President, exhibited and described an *Experiment for showing the Contraction of Water above the Freezing-point.*—The water operated on was contained in a glass jar about 4 in. in diameter and 18 in. high; and the changes in its density were shown by the ascent and descent of coloured glass balls about 1 in. in diameter. When the water was ice-cold, the balls were all at the bottom; but gradually, as the warmth of the room was communicated to the water, its contraction and consequent increase of density caused the balls to rise. As the water approached the state of greatest density, the heavier balls were seen to move irregularly about in consequence of the current caused by the changes of temperature. In the course of an hour the point of maximum density having been passed, the balls began to descend in reverse order, and at last all again reached the bottom. Mr. Sang added that, although he had never seen any published description of this experiment, he could scarcely expect it to be new, seeing that it is an obvious extension of a well-known method for demonstrating the compressibility of water.

ROYAL INSTITUTION OF GREAT BRITAIN.

February 12, 1858.
H.R.H. The Prince Consort, K.G., D.C.L., F.R.S., Vice-Patron, in the Chair.
Professor Faraday, D.C.L., F.R.S.

REMARKS ON STATIC INDUCTION.

The object of the speaker was to give to the members of the Royal Institution a simple reference to the production and nature of the static phenomena of electricity, especially in respect of induction, into which indeed they all resolve themselves. When flannel, shell-lac, metal, and sulphur, are any two of them rubbed together they become electrified in the well-known manner; and in such order that any one of them becomes negative to those which precede it in the list, or positive to these which follow. Thus, metal becomes negative to shell-lac, and positive to sulphur; and as either of these substances can be employed in the investigation of the fundamental principles of induction, this difference is important in some of the methods of examining by the electrometer their temporary or permanent state. If a stick of shell-lac have a flannel cap fitted to one extremity, both being unexcited, and these, either separate or associated, be examined by the gold-leaf electrometer, they will show no signs of electricity. If the cap, grasped by the hand, be turned round on the shell-lac with friction, but left in its place, the associated substances will still show no signs of electricity. If separated, each will show a strongly excited state opposite to that of the other. If one be laid on the cap of the electrometer (the gold leaves of which were 7 in. long and 1½ in. wide, with perfect insulation) it will show a highly excited state; if the other be gradually brought near, and finally placed by the side of the first, all the electric signs will disappear, to reappear when the separation is again produced. The experiment presents a type case of excitation and induction. By the friction together the opposite electricities are excited; they then exist and keep their state by mutual induction; they are perfectly equivalent to each other, and hold their existence by this definite and relative equivalency; for one electricity cannot exist by itself. They show no external signs of electricity whilst the forces are related only to each other, but when the two bodies in which the states are located are separated, then this relation is not exclusive, but by so much as the induction is diminished between the two substances, it is thrown in other directions; as towards the electrometer, or the walls of the room. When one is carried into a separate room, or put into a vessel of conducting matter, then the excited bodies become independent of each other; each has raised up an equal amount of the contrary force by action terminating at a distance, according to the laws of ordinary induction. The power exerted by each excited body in this distant action may be expressed by the term, lines of force. These lines, or the force they represent, is sustained, so long as they are contained in or pass through an insulating medium. They continue, until meeting with conducting matter they evolve the contrary state to that which they originate, and in the equivalent proportion, and so terminate the insulation; or failing that, they continue their course outwards. If it were possible to place the excited shell-lac in the centre of an almost infinite extent of insulating medium, the lines of force would be as infinitely extended from it. If the power at any section of the whole of the lines of force could be compared with that at any other section, they would be found equal to each other; though one section might be close to the shell-lac, and the other at an infinite distance. If there were no conducting matter at the boundaries of the insulating space above supposed, the shell-lac could not exist independently in the excited state: it would then keep its lines of force altogether turned upon the body by which it had first been excited, the induction between the two being sustained by their reciprocal action, without which electricity could neither be excited nor exist. Such are some of the consequences which follow inevitably upon the laws of static induction, combined with the law of the conservation of force.

But if this function of induction be so essential to the very existence of

electricity in its developed or active state, what is its nature? It acts through distance and across intervening bodies: how are the space and the bodies affected? In all actions at a distance it is most important to ascertain, if possible, what occurs in the intervening medium, or the interposed space; whether the investigation ends in the establishment of a particular process for the particular case, or the reference of the process to any more general mode of action representing all cases of distant action.

Induction acts across any insulating body, whether it be solid, fluid, or gaseous. Common air is concerned in most inductive actions, but being mobile, its particles cannot be retained in a given place, position, or state, so as to allow of close examination. Sulphur and shell-lac are excellent bodies as subjects of investigation, the more especially as their *specific inductive capacity* is about twice that of air; and being solid bodies, their superficial or bounding particles can be thrown into a given state, yet preserved in their place to be examined with the purpose of showing what that state is. If a round plate of metal, 9 in. in diameter, be set up vertically in the air and insulated, and a like plate of good gutta percha raised on an insulating pillar be placed parallel to and about 9 in. from it, then, upon exciting the gutta percha, strong induction occurs. The gutta percha presents the inductric, the copper plate the inducteous, surfaces which limit the field of induction, which field supplies an excellent place for experiment. The gutta percha should be excited by a piece of close broadcloth, free from loose particles, and all dust, or other sources of convective effects should be avoided. Plates of sulphur, about 3 in. or 4 in. square, and 1 in. thick, may be employed as the inductive medium, and these having white silk loops introduced into the edges when cast, may by the further use of white silk slings, be suspended or handled with perfect facility. Some discs of stiff paper, gilt on both sides, being attached at the edge to thin stems of shell-lac, are thus well insulated, and serve either as metallic plates or carriers.

It is almost impossible to take a block of sulphur out of paper, or from off the table without finding it electric; if, however, a small spirit-lamp flame be moved for a moment before its surface at about an inch distance, it will discharge it perfectly. Being then laid on the cap of the electrometer it will probably not cause divergence of the gold leaves; but the proof that it is in no way excited is not quite secure until a piece of uninsulated tinfoil or metal has been laid loosely on the upper surface. If there be any induction across the sulphur, due to the feeble excitement of the surfaces by opposite electricities, such a process will reveal it: a second application of the flame will remove it entirely. When a plate of sulphur is excited on one side only, its application to the electrometer does not tell at once which is the excited side. With either face upon the cap the charge will be of the same kind, but with the excited side downwards the divergence will be much, and the application of the uninsulated tinfoil to the top surface will cause a moderate diminution, which will return as the tinfoil is removed; whereas, with the excited side upwards, the first divergence of the leaves will be less, and the application of the tinfoil on the top will cause considerable diminution. The approximation of the flame towards the excited side will discharge it entirely. The application near the unexcited side will also seem partly to discharge it, for the effect on the electrometer will be greatly lessened; but the fact is, that the flame will have charged the second surface with the *contrary* electricity. When therefore the originally excited surface is laid down upon the cap of the electrometer, a diminished divergence will be obtained, and it is only by the after application of uninsulated tinfoil upon the upper surface that the full divergence due to the lower surface is obtained.

Being aware of these points, which are necessary to safe manipulation, and proceeding to work with a plate of sulphur in the field of induction before described, the following results are obtained. A piece of uncharged sulphur being placed in the induction field parallel of course to the gutta percha and copper plates, and retained there, even for several minutes, provided all be dry and free from dust and small particles, when taken out and examined by the electrometer, either without or with the application of the superposed tinfoil, is found without any charge. The gilt plate carrier before described, if introduced in the same position and then withdrawn, is found entirely free of charge. If the sulphur plate be in place, and then the carrier be introduced and made to touch the face of the sulphur, then separated a small space from it, and brought away and examined, it is found without any charge; and that whether applied to either one side or the other of the block of sulphur. So that any of these bodies, which may have been thrown into a polarized or peculiar condition whilst under the induction, must have lost that state entirely when removed from the induction, and have resumed their natural condition. Assuming, however, that the sulphur had become electrically polarized in the direction of the lines of induction, and that therefore whilst in the field one face was positive and the other negative, the mere touching of two or three points by the gold leaf carrier would be utterly inefficient in bringing any sensible portion of this charge or state away; for though metal can come into *conduction contact* with the surface particles of a mass of insulating matter, and can take up the state of that surface, it is only by real contact that this can be done. Therefore the two sides of a block of sulphur were gilt by the application of gold leaf on a thin layer of varnish, and when the varnish was quite dry and hard this block was experimented with. Being introduced into the induction field for a time and then brought away, it was found free from charge on both its surfaces; being again introduced, and the carrier placed between it and either the gutta percha or the copper plate, but not touching these or the sulphur, the carrier when brought away showed no trace of electricity. The carrier being again introduced at the inductive or gutta percha side, made to touch the gilt surface of the sulphur on that side, separated a little way and then brought out to be examined, gave a positive charge to the electrometer: when it was taken to the other side of the sulphur and applied in the same manner, it brought away a negative charge. Thus showing, that whilst the sulphur was under induction, the side of it towards the negative gutta percha was in the positive state, and the side towards the positive inducteous surface of copper bounding the extent of the induction field, was in the negative state. Thus the dielectric sulphur whilst under induction is in a constrained polar electrical state, from which it *instantly* falls into an indifferent or natural condition the moment the induction ceases, either by the removal of the sulphur or the gutta percha. That this return action is due to an electrical tension *within* the mass, sustained while the act of induction continues, is evident by this, that if the carrier be applied two or three times alternately to the two faces, so as to discharge in part the electricity they show under the induction, then on removing the sulphur from the induction field it returns, not merely to neutrality or indifference, but the surfaces assume the opposite states to what they had before; a necessary consequence of the return of the mass of inner particles to or towards their original condition.

The same result may be obtained, though not so perfectly, without the use of any coatings. Having the uncoated sulphur in its place, put the small spirit lamp between it and the copper plate; bring up the excited gutta percha to its place, remove the spirit-lamp flame, and then the gutta percha; and finally, examine the sulphur: the surface towards the flame, and *that only*, will be charged—its state will be found to be positive, just like the same side of the gilt sulphur which had been touched two or three times by the carrier. During the induction the mass of the sulphur had been polarized; the anterior face had become positive; the posterior had become negative; the flame had discharged the negative state of the latter; and then, on relieving the sulphur from the induction, the return of the polarity to the normal condition had also returned the anterior face to its proper and unchanged state, but had caused the other, which had been discharged of its temporary negative state whilst under induction, now to assume the positive condition. It would be of no use trying the flame on the other side of the sulphur plate, as then its action would be to discharge the gutta percha, and destroy the induction altogether.

When several plates were placed in the inductive field apart from each other, subject to one common act of induction, and examined in the same manner, each was found to have the same state as the single plate described. It is well known that if several metallic plates were hung up in like manner, the same results would be obtained. From these and such experiments, the speaker took occasion to support that view of induction which he put forth twenty years ago,* which consists in viewing insulators as aggregates of particles, each of which conducts within itself, but does not conduct to its neighbours, and induction as the polarization of all those particles concerned in the electric relation of the inductric and inducteous surfaces; and stated, that as yet he had not found any facts opposed to that view. He referred to specific inductive capacity, now so singularly confirmed by researches into the action of submarine electro-telegraphic cables, as confirming these views; and also to the analogy of the tourmaline, whilst rising and falling in temperature, to a bar of solid insulating matter, passing into and out of the inductive state.

Friday, March 26, 1858.

Sir Benjamin Collins Brodie, Bart., D.C.L., F.R.S., Vice-President, in the Chair.

Rev. John Barlow, M.A., F.R.S., Vice-President and Secretary, R.I.

ON MINERAL CANDLES AND OTHER PRODUCTS MANUFACTURED AT BELMONT AND SHERWOOD.

The candles and the other products (liquid hydro-carbons) on which Mr. Barlow discoursed are manufactured by Price's Candle Company, at Belmont and Sherwood, according to processes patented by Mr. Warren De la Rue. The novelty of these substances consists—1. In the material from which they are obtained. 2. In the method by which they are elaborated. 3. In their chemical constitution.

1. *The raw material* is a semifluid naphtha, drawn up from wells sunk in the neighbourhood of the river Irrawaddy, in the Burmese empire. The geological characteristics of the locality are sandstone and blue clay. In its raw condition the substance is used by the natives as a lamp-fuel, as a preservative of timber against insects, and as a medicine. Being in part volatile, at common temperatures, this naphtha is imported in hermetically-closed metallic tanks, to prevent the loss of any constituent. Reichenbach, Christison, Gregory, Reece,† Young,‡ Wiesman (of Bonn), and others, have obtained from peat, coal, and other organic minerals, solids and liquids bearing some physical resemblance to those procured from the Burmese naphtha; but the first-named products have, in every instance, been formed by the decomposition of the raw material. The process of De la Rue is, from first to last, a simple separation, without chemical change.

2. *The processes adopted.*—In the commercial processes, as carried out by Mr. George Wilson, at the Sherwood and Belmont Works, the crude naphtha is first distilled with steam at a temperature of 212° Fahr.; about one-fourth is separated by this operation. The distillate consists of a mixture of many volatile hydro-carbons; and it is extremely difficult to separate them from each other on account of their vapours being mutually very diffusable, however different may be their boiling points. In practice, recourse is had to a second or third distillation, the products of which are classified according to their boiling points or their specific gravities, which range from ·627 to ·860, the lightest coming over first. It is worthy of notice, that though all these volatile liquids were distilled from the original material with steam of the temperature of boiling water, their boiling points range from 80° Fahr. to upwards of 400° Fahr.

These liquids are all colourless, and do not solidify at any temperature, however low, to which they have been exposed.§ They are useful for many pur-

---

* Phil. Trans., 1837.

† See Proceedings of the Royal Institution, Vol. 1, p. 4. ‡ Ibid, p. 135.

§ The freezing mixture of solid carbonic acid and ether does not affect the fluidity of these bodies.

poses. All are solvents of caoutchouc. The vapour of the more volatile, Dr. Snow has found to be highly anæsthetic. Those of the lower specific gravity, called in commerce *Sherwoodole*, have great detergent power, readily removing oily stains from silk, without impairing even delicate colours. The distillates of higher specific gravity are proposed to be used as lamp-fuel; they burn with a brilliant white flame, and, as they cannot be ignited without a wick, even when heated to the temperature of boiling water, they are safe for domestic use.

A small per-centage of hydro-carbons, of the benzoles series, comes over with the distillates in this first operation. Messrs. De la Rue and Müller have shown that it may be advantageously eliminated by nitric acid. The resulting substances, nitro-benzole, &c., are commercially valuable in perfumery, &c.

After steam of 212° has been used in the distillation just described, there is left a residue, amounting to about three-fourths of the original material. It is fused, and purified from extraneous ingredients (which Warren de la Rue and H. Müller have found to consist partly of the colophene series) by sulphuric acid. The foreign substances are thus thrown down as a black precipitate, from which the supernatant liquor is decanted. The black precipitate, when freed from acid by copious washing, has all the characteristic properties of native asphaltum. The fluid is then transferred to a still, and, by means of a current of steam, made to pass through heated iron tubes, is distilled at any required temperature. The distillates obtained by this process are classed according to their distilling points, ranging from 300° to 600° Fahr. The distillations obtained at 430° Fahr. and upwards, contain a solid substance, resembling in colour and in many physical and chemical properties the paraffine of Reichenbach; like it, it is electric, and its chemical affinity is very feeble: but there are reasons for believing that a difference exists in the atomic constitution of the two substances. The commercial name of *Belmontine* is proposed for the solid derived from the Burmese naphtha. Candles manufactured from this material possess great illuminating power. It is stated that a Belmontine candle, weighing one-eighth lb., will give as much light as a candle weighing one-sixth lb. made of spermaceti or of stearic acid. Its property of fusing at a very low temperature into a transparent liquid, and not decomposing below 600° Fahr. recommends this substance as the material of a bath for chemical purposes. As to the fluids obtained in the second distillation, already described, they all possess great lubricating properties; and, unlike the common fixed oils, not being decomposable into an acid, they do not corrode the metals, especially the alloys of copper, which are used as bearings of machinery. This aversion to chemical combination, which characterizes all these substances, affords, not only a security against the brass-work of lamps being injured by the hydro-carbon burnt in them, but also renders these hydro-carbons the best detergents of common oil-lamps. It is an interesting physical fact that some of the non-volatile liquid hydro-carbons possess the fluorescent property which Stokes has found to reside in certain vegetable infusions.

3. *Chemical constitution of these hydro-carbons.*—On this subject there will be found a short memoir by Warren de la Rue, and Hugo Müller, in the Proceedings of the Royal Society, Vol. viii., page 221. The researches referred to in that memoir are nearly completed. The principal constituents of the Burmese naphtha are (*a*), (the largest in proportion) a substance identical in composition with either the hydurets or the radicals of the ethyle series; (*b*) substances of the benzole series, forming a comparatively small portion. It has however been ascertained that some of the hydro-carbons of this aromatic series differ in their chemical and physical properties from the analogous members of the same series obtained from the usual sources. This difference is most strongly marked in the case of cumole and its higher homologues of the benzole series,* (*c*) the colophene series already adverted to.

An important characteristic of the Burmese naphtha is its being almost entirely destitute of the hydro-carbons belonging to the olefiant gas-series.

ILLUSTRATION OF THE ACTION OF THE SLIDE-VALVE.

By Mr. Robert McEwen, H.M.S. *Curaçoa.*

The action of the slide-valve of the steam-engine, under variations of lap, lead, and stroke, though a subject of much importance and consideration in the proper construction and economical working of engines, yet, from the valve being hidden when in operation, its relative action to the piston and crank is not so discernible to practical inspection as are other parts of the engine, and the action of the valve has, consequently, been generally solved and explained by mathematical analysis, which fails to afford that speedy, clear, and comprehensive view of the subject so desirable to practical men in dealing with the arrangements and working of the steam-engine.

Having many years ago, when expansion valves were first beginning to be applied to factory engines, felt some doubts and difficulty in regard to their adjustment and action in connection with the slide-valve, being desirous also to ascertain the result of variations in the lap, &c., and finding the usual mode of hand-spiking the fly-wheel round in setting and adjusting the valves rather a tedious and laborious way of arriving at the wished-for result, I was forced to devise some easier and speedier method of solving the matter, and which was attained with sufficient accuracy for practical purposes by the following plan, of which the accompanying diagram will afford an illustration.

Fig. 1 represents the battens or straight edges, as used by engineers to mark off the dimensions and position of the steam-ports and valve-faces, as a guide for adjusting the length of valve-rods and setting the slide-valve.

Fig. 2 represents a diagram, drawn full-sized on a floor or other suitable place, describing the revolution, *a, a*, made by the centre of crank-pin, the vertical line of diameter corresponding to the length of stroke, being divided into inches, or other equal parts, which are drawn to cut the circle, *a, a*, with a radius, *b*, equal to the length of connecting-rod. A piece of wood with a large end, to represent the crank, *c*, was placed on a pin in the centre of the circle, *a, a*, having a circle, *d*, described on it equal to the throw of the eccentric. A rod, *e*, of the length of the eccentric-rod, held temporarily by a bradawl at each end, so as to be easily altered or adjusted, was attached between the valve batten and eccentric line of throw-on crank, and thus completed the apparatus.

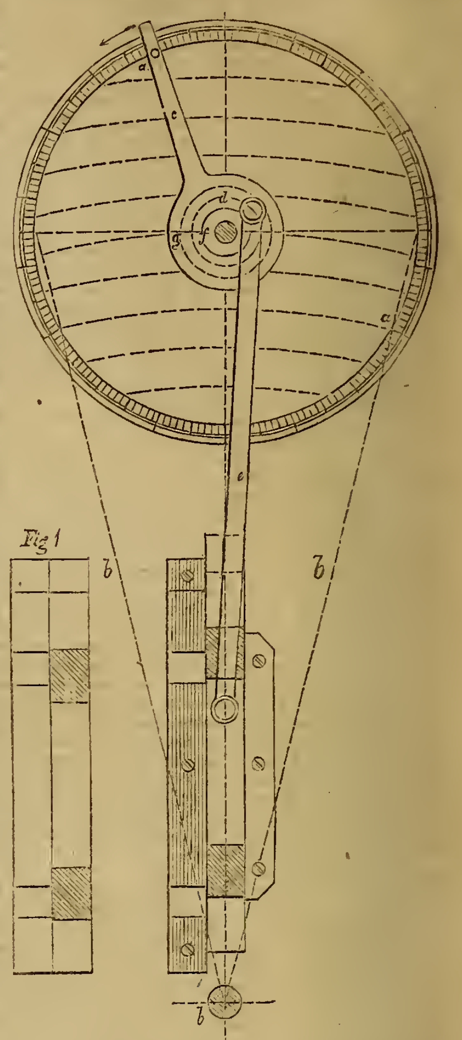


Fig. 2.

Its operations in solving the action of the slide valve, with variations of lap, &c., will be readily comprehended; first, adjust the position of the eccentric-rod so as to traverse the batten representing the valve equally across the steam ports, then with the crank on top or bottom centre set the valve with the desired lead, and fix the eccentric rod with the bradawl on the required line of throw of the eccentric, giving steam for the direction in which the crank is to revolve, then by moving the crank round in that direction the points of the stroke are shown at which the steam is cut off and educted; and by changing the lines representing the breadth of cover or valve-face on the batten, or changing the length of valve stroke, by attaching the eccentric-rod on a different line of throw, as F, or G, the effects of such alterations are also shown on the steam and eduction ports.

I would now point out what appear to be misconceptions in regard to the proper proportions and action of the slide-valve, and which may be readily tested by the apparatus described, aided and checked by diagrams taken with the indicator; and first, the effect of the varying motion of the piston and slide-valve in their relation to each other at different portions of their stroke, incidental to the conversion by crank and connecting-rod of reciprocating rectilinear into rotary motion, and *vice versâ*, seems not to be generally or practically taken into account in estimating the movements of the valve, or we should not have seen so many attempts to work the slide valve by a camb, as if the eccentric did not open the valve quick enough at the turn of the strokes. The apparatus described, and the indicator, will both show pretty clearly that the slide valve, when properly constructed, is opened quite quick enough by the eccentric at the turning of the stroke. But to show the matter in another way, and illustrate the variation in the times of the travel of the piston through equal but different portions of the stroke, let the circle described by the crank-pin be divided on its diameter into a number of equal parts of the stroke, say ten, as shown in the diagram, and draw these by the radius of the length of connecting rod to cut the circle described by crank pin; around the circle described by crank-pin, draw a scale of degrees or equal parts, as shown on the diagram, and as the crank pin for practical purposes may be reckoned to move through equal spaces in

* In illustration of this view may be cited, Church's discovery of a parabenzole in coal tar, boiling at 185° Fahr., and not solidifying at 32°.

equal times, the difference in the times between any portions of the piston's travel will indicate the variation in the speed of the piston, as, for example, the times of travel of the concluding tenth of the stroke is at the upper end of the diagram 21·5, at the lower 16·5, while the central portions are only 5·5, and thus, while the piston is travelling with a decreased motion through the extreme portions of its stroke, the valve, on the other hand, is performing the central and quickest portion of its stroke.

Were it not that I have already trespassed too far on your valuable space, there are some other matters relating to the proportions and action of the slide valve that merit discussion, a few of which allow me briefly to allude to; for example, the amount of lap that a valve ought to have, with due consideration for economising steam, and facility in handling the engines. The lap has certainly in many cases been carried to excess, as better results could be obtained with a less amount of lap by the use of the expansion valve in connection with the slide valve. The saving in fuel resulting from the extended and general application of lap to the valve some years ago has been generally, though questionably, attributed solely to the advantages derived from the expansion of the steam; whereas the quicker and fuller opening of the eduction side of the valve, consequent on the addition of lap to the steam side, may fairly be reckoned to have equally contributed to the saving of fuel, by the formation of a quicker and better vacuum. A comparative trial by the apparatus described, of a slide valve of the old kind, without almost any lap, and one with the addition of lap, will clearly show the advantages conferred on the eduction side of the valve by the addition of lap to the steam side; and probably as a general rule for determining the amount of lap that is requisite to a valve, regard should be had more to its effect on the openings for eduction, leaving to the expansion valve the chief management of the steam on the steam side of the slide valve.

The effect of the lead given to the slide valve is generally over-rated as regards its cushioning action, as the rounding off, showing at times by indicator diagrams, and attributed to the lead of the valve, will be found generally to proceed from a leaky piston. The steam passing through being shut off from entering the condenser by the lap of the valve closing the eduction port, and the uncondensed vapour due to the imperfect vacuum in the cylinder, also assists, when shut off from the condenser, to give an increasing resistance to the piston, and hence one evil effect of much lap. It will be found that the general amount of lead given to the valve, usually from one-eighth to three-eighths of an inch, operates on a very small fractional part of the piston's stroke; but that and many other matters, such as the effect of long or short connecting and eccentric rods on the action of the slide valve, will be readily ascertained by trial with the apparatus I have endeavoured to explain, which may be constructed in an hour or so, and in less time on a reduced scale, as it may be made with a few strips of cardboard, and fastened by pins on a drawing board, so as to solve in a rough way problems connected with the action of the slide valve.

AMERICAN NOTES.

UNITED STATES REVENUE STEAMER "HARRIET LANE."

THIS vessel, the principal dimensions and particulars of which are given below, has just been completed in this city, by Wm. H. Webb, Esq., who contracted with the United States Government to furnish her complete in every particular. Her construction was authorized by a late Act of Congress, upon an application of the underwriters and merchants of this city, who asked for a steamer expressly constructed for service in this harbour and the adjacent sea coast, for the purpose of relieving vessels in distress, suppressing mutinies on board of vessels, &c.

Under the skilful and experienced direction of Mr. Webb, who designed and directed her hull and equipments, aided by T. F. Secor, Esq., of the Allaire Works, who designed her machinery, this vessel presents an instance of rare success in all her qualities, and is a source of pride to all connected with her.

In addition to high speed she possesses the desirable element of full capacity for her requirements, a draft of water within that assigned to her, and great efficiency as a sailing vessel alone. Her armament consists of two medium 32-pounder guns upon her quarter deck, and one pivot gun forward. She has a crew of forty-five men, and is commanded by Captain John Faunce, so well and so favourably known upon this station.

As several agents of foreign Governments have of late given their orders for the construction of steamers to parties in this country, it is well to suggest to these agents that before entering into a contract that they first advise themselves of what has been done and who did it; for, if such a course was observed, we should not have been placed in the position that we undeservedly have been upon more than one occasion; the developments of this vessel, however, we feel confident, will go far to remove any doubts that may exist as to the ability of American shipowners, builders, and engineers.

DIMENSIONS OF UNITED STATES REVENUE STEAMER "HARRIET LANE."

Hull built by William H. Webb, New York; Engines by T. F. Secor and Co., Allaire Works, New York.

	Ft.	In.
Length on deck	180	0
Ditto at load-line	177	6
Breadth of beam (moulded)	30	0
Depth of hold	12	6
Depth of hold to spar deck	12	6
Area of immersed section at load draft of 10 ft.	270 sq. ft.	
Hull; Engine-room	640 tons.	

Description of engines, inclined direct; ditto boilers, return flued; diameter of cylinders, two of 42 in.; length of stroke, 7 ft.; diameter of water wheel over boards, 22 ft. 6 in; length of wheel blades, 8 ft.; number of ditto, 20. Number of boilers, 2; length of ditto, 24 ft.; breadth of ditto, 9 ft. 3 in.; height of ditto, exclusive of steam chimney, 10 ft. 1 in. Number of furnaces, 4; breadth of ditto, 4 ft.; length of grate bars, 6 ft. 6 in.; number of flues above, 5; ditto below, 10; internal diameter of ditto above, 1 ft. $5\frac{1}{2}$ in.; ditto below, $13\frac{1}{2}$ in.; length of ditto above, 18 ft.; ditto below, 12 ft. 6 in.; diameter of smoke-pipe, 5 ft. 4 in.; height of ditto, 47 ft.; draft forward, ditto aft (loaded), 10 ft. Date of trial, March, 1858. Dip of wheel, 4 ft. 5 in.; heating surface, 2,500 sq. ft.; consumption of fuel per hour, two-thirds of a ton; maximum pressure of steam, 25 lbs.; point of cutting off, one-half; maximum revolutions at above pressure, $22\frac{1}{2}$; weight of engines, 133 tons; ditto boilers, without water, 90,000 lbs.

Frames moulded, 13 in.; sided, 14 in.; 28 in. apart from centres, and strapped with diagonal and double laid braces, 4 in. by $\frac{1}{2}$ in.; depth of keel, 10 in.; width of ditto, 15 in.; independent steam, fire, and bilge pumps, 1; masts, two; rig, brigantine; number of bulkheads, 2.

Intended service, United States sea coast.

DIMENSIONS OF STEAMER "JAPANESE."

Hull built by William H. Webb, New York; Engines by Novelty Iron Works, New York.

	Ft.	In.
Length on deck	214	0
Do. at load line	212	0
Breadth of beam (moulded)	36	0
Depth of hold	10	0
Depth of hold to spar deck	17	6
Length of engine room	20	0
Area of immersed section at load draft	380	0
	Tons.	
Hull	950	
Engine Room and bunkers	350	

Description of engine, horizontal oscillating; ditto boilers, return flued; diameter of cylinders, 4 ft. 3 in.; length of stroke, 3 ft.; diameter of screw, 11 ft.; pitch of screw, 21 ft.; number of blades of screw, 3. Number of boilers, 2: length of ditto, 24 ft. 6 in.; breadth of ditto, 12 ft. 9 in.; height of ditto, exclusive of steam chimney, 12 ft. 9 in. Number of furnaces, 10: breadth of ditto, 3 ft.; length of grate bars, 6 ft. 9 in. Number of flues above, 18; ditto below, 15; internal diameter of ditto above, 11 in. and 13 in.; ditto below, 15 in.; length of ditto above, 18 ft. 9 in.; ditto below, 12 ft.; diameter of smoke-pipe, 6 ft. 3 in.; height of ditto (telescopic), 36 ft. 6 in.; draft forward, ditto aft (load), 12 ft. 6 in. Date of trial, April, 1858. Heating surface, 5,728 sq. ft.; contents of bunkers, 400 tons; maximum pressure of steam, 25 lbs.; point of cutting off, 1-6th to $\frac{3}{4}$; maximum revolutions at above pressure, 50; weight of engines, 234,000 lbs.; ditto boilers, with water, 138 tons.

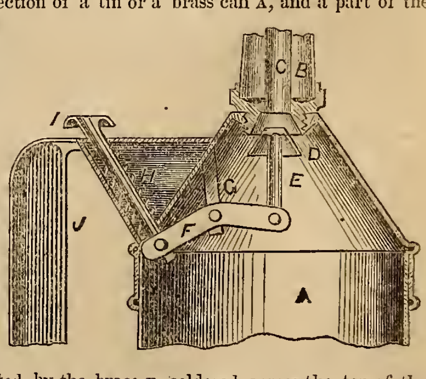
Frames molded, 15 in.; sided, 15 in.; 30 in. apart from centres, and strapped with diagonal and double laid braces, $4\frac{1}{2}$ in. by $\frac{3}{4}$ in; depth of keel, 12 in.; independent steam, fire, and bilge pumps, 1; masts, 3; rig, barque; number of bulkheads, 2.

Intended service: built for the Russian Government.

VAN HAGEN'S OIL CAN.

THIS device has obtained great popularity on our leading roads and steamers. Being designed to save oil, that is to deliver it instantly at the 'holder's option,' and not to deliver it at any other point than at the oil hole; its adoption by all users of machinery will effect a great economy.

The cut shows a vertical section of a tin or a brass can A, and a part of the spout. The bottom being the most exposed and perishable part, it is here made of cast iron, as shown at K. The conical top is lapped over the cylindrical part, forming a strong joint.



The spout is double for the sake of greater strength. At the junction of the conical tube B, and the straight tube C, a copper nozzle is soldered on. The whole spout has a brass thimble at its lower end which screws into the brass top of the can. The feed apparatus is the reverse of that sometimes used.

The conical valve D, supported by the brace E, soldered across the top of the can, is moved by the lever F, the hollow wire H, and the thumb-piece I. By

pressing the thumb on I the can may be inverted and the spout placed directly over the oil hole without waste of the unguent. By removing the thumb the desired quantity at once flows out, air entering through H. When the can is again erect, the oil in the small passages does not gum and congeal but flows back into the can, because the air which would otherwise hold it up flows out at H. The spiral spring around H holds the valve D open.

The perfect ventilation, rapid delivery, cheapness and durability of these cans are justly bringing them into extensive use.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

ABEL (F. A.) and BLOXAM (C. L.)—Hand-book of Chemistry, Theoretical, Practical, and Technical. By F. A. Abel and C. L. Bloxam. 2nd edition, 8vo, pp. 800, cloth, 15s. (Churchill.)

CHALMERS (C.)—Electro-Chemistry, with Positive Results, and Notes for Inquiry on the Sciences of Geology and Astronomy; with a Tract of Miscellanies. By Charles Chalmers. 8vo, pp. 100, cloth, 3s. 6d. (Churchill.)

ILLUSTRATED INVENTOR (The).—Vol. 1, folio, cloth, 13s. (Office.)

MATHER (J.)—Ships and Gales; Harbours of Refuge. By J. Mather. 8vo, sewed, 1s. (Longman.)

RANKINE (W. J. M.)—A Manual of Applied Mechanics. By William John Macquorn Rankine, with numerous Diagrams. Post 8vo, pp. 630, cloth, 12s. 6d. (Encyclopædia Metropolitana.) (Griffin.)

SAYER (A.)—London Main Drainage; the Nature, Value, and Disposal of Sewage, with Considerations on Drainage, Sewers, and Sewerage, Sketches of the Water Supply, and of the Legislation on Sewers, Ancient and Modern. By A. Sayer. 2nd edition, 8vo, pp. 150, sewed, 1s. 6d. (F. W. Calder.)

STEVENSON (D.)—Canal and River Engineering; being the Article "Inland Navigation," from the Eighth Edition of the Encyclopædia Britannica. By David Stevenson. 8vo (Edinburgh), pp. 170, cloth, 4s. 6d. (Longman.)

*COALE (G. B.)—Manual of Photography; adapted to Amateur Practice. Whipple's Albumen Process. By George B. Coale. 12mo (Philadelphia), limp cloth, pp. 82, London. 8s.

*REID (D. B.)—Ventilation in American Dwellings; with a Series of Diagrams, presenting Examples in Different Classes of Habitations. By David Boswell Reid, M.D. To which is added, an Introductory Outline of the Progress of Improvement in Ventilation. By Elisha Harris, M.D. 8vo (New York), illustrated, pp. 124, cloth, London. 12s.

*VOSE (G. L.)—Handbook of Railroad Construction for the Use of American Engineers; containing the necessary Rules, Tables, and Formulæ for the Location, Construction, Equipment, and Management of Railroads, as built in the United States, with 150 illustrations. By George L. Vose, Civil Engineer. 8vo (New York), pp. 480, cloth, London. 18s.

ADAM (W.)—First Lessons in Geology; with a Special Article on the Sandstones of Derbyshire, and a Glossary explanatory of Geological Terms and their Derivations; with Sections and a General Diagram of the Strata. By W. Adams. 18mo (Derby), pp. 174, sewed, 1s. 6d. (Mozley.)

BLOWPIPE (a System of Instruction in the Practical Use of the); being a Graduated Course of Analysis, for the use of Students and all those engaged in the Examination of Metallic Combinations. Post 8vo, pp. 268, cloth, 7s. (Baillière.)

LAMING (R.)—Static Induction; Charging Capacities, Attractions, and Repulsions, Arithmetically deduced from a Ponderable Electricity allotted to Bodies in Quantities denoted by their Weights. By Richard Laming, M.R.C.S. 8vo, 1s. (Taylor and F.)

MANTELL (G. A.)—Medals of Creation; or, First Lessons in Geology, and in the Study of Organic Remains: including Geological Excursions to the Isle of Sheppy, Brighton, Lewes, Tilgate Forest, Charnwood Forest, Faringdon, Swindon, Calne, Bath, Bristol, Clifton, Matlock, Crich Hill, &c. By Gideon Algernon Mantell, LL.D., F.R.S., &c. 2nd edition, extensively revised, with coloured plates, and several hundred beautiful woodcuts of Fossil Remains. 2 vols., post 8vo, cloth, 15s. (Bohn's Scientific Library.)

PATTEN (W.) — The Complete Slide Rule Instructor: containing upwards of Three Hundred Questions and Solutions for the Improved Slide Rule; adapted for the Use of Engineers, Millwrights, Cotton Spinners, Mechanics, Blacksmiths, Moulders, and Artizans in general. By William Patten. 12mo, pp. 80, cloth, 1s. (Kent.)

TODHUNTER (I.)—A Treatise on Plane Co-ordinate Geometry, as applied to the Straight Line, and the Conic Sections; with numerous Examples. By I. Todhunter. 2nd edition, post 8vo (Cambridge), cloth, 10s. 6d. (Bell.)

WEALTH WITHOUT MONEY; or, Suggestions for the Practical Development of the Boundless Resources of Nations. By a Civil Engineer. 2s. 6d. (Thacker.)

BREWSTER (Sir D. B.)—The Kaleidoscope; its History, Theory, and Construction: with its Application to the Fine and Useful Arts. By Sir David Brewster. 2nd edition, enlarged, post 8vo, pp. 190, cloth, 5s. 6d. (Longman.)

CHAPMAN (J. C.)—The Amateur's Drawing Manual and Basis of Study for the Professional Artist; comprehending Elementary Drawing, Perspective, Sketching from Nature, Painting, Etching and Engraving, Modelling and Composition: especially adapted to the use of Public and Private Schools, as well as Home Instruction. By J. C. Chapman. 4to, pp. 300, cloth, 21s. (Longman.)

FODEN.—Mechanical Tables. 3rd edition, corrected and amended, 12mo, pp. 51, cloth, 1s. 6d. (Longman.)

HYMERS (J.)—A Treatise on Plane and Spherical Trigonometry, and on Trigonometrical Tables and Logarithms; together with a Selection of Problems and other Solutions. By J. Hymers. 4th edition, 8vo, pp. 236, cloth, 8s. 6d. (Longman.)

TRANSACTIONS of the National Association for the Promotion of Social Science, 1857. Inaugural Address and Select Papers. 8vo, pp. 640, cloth, 15s. (Longman.)

Marked thus (*) are American works.

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*—Ed.]

To the Editor of The Artizan.

Sir,—Mr. Atherton's remarks upon my estimate of the speed of the *Leviathan* are somewhat disingenuous. He must have perceived that by "miles" I meant *nautical miles*; if not, I must have supposed that her speed on sea-service would be about the same as that upon her trial trip. He knew that I did not suppose that. I reckon she will go at the rate of 19 or 20 nautical miles per hour on her trial trip, when, no doubt, she will be at that draft of water which is calculated to admit of her maximum speed; and I expect that her average speed, at a medium load line, will be 16 or 17 knots per hour, as I before stated, while her bottom remains clean. The retardation from the foulness which accumulates upon an iron ship's bottom is enormous. I had to do with one a few weeks back which made 10 knots an hour on her outward passage, and, coming home, the captain assured me he "could not get 6 knots out of her," on account of the barnacles and filth which adhered to her bottom. But I repeat, I attach no importance whatever to my estimate of the *Leviathan's* speed. In calculating the probable speed of a ship having so much of novelty about her, one is beset with such a complication of considerations that I felt, after devoting many hours to the subject, that my calculations had nothing like mathematical certainty about them. I frankly said so, and I repeat the assertion. My figures, which I have carefully revised, show that she *ought* to have the speed I state. Still I have a misgiving that she will not go quite so fast; but this may arise from a want of familiarity with such a high velocity.

But Mr. Atherton's disingenuousness has another phase, which it is not very agreeable to discover in a gentleman who occupies so worthily a high professional position; and who, on other grounds, is entitled to so much respect. He affects to believe that I objected to his table because it was to a small extent at variance with my "guess," and that, therefore, I denounced his formula $\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} = C$. Whereas, my objection to it was, not that it differed from my conjecture, but that it differed from itself—that it contained what appeared to me to be *a glaring discrepancy*.

If, apart from his formula, which is only adapted to produce coefficients which require another formula for their equation, he had said, "I have sedulously availed myself of all the valuable data I possess—I have intently brought my experienced mind to bear upon the subject—and I am ready to stake my professional reputation upon the issue—the maximum speed of the *Leviathan* will be no more than 15·76 nautical miles per hour, with 12,000 indicated H.P., and at 20 ft. draft of water," I assure him that I should have deemed my guess but as a feather in the scale opposed to the weight of such an authority; but it seemed to me that his mind had not had fair play—that the formula to which he clings with the fervour of a poor Indian to his fetich had betrayed him, and that his Table exhibited irrefragable evidence of this fact. Perhaps, Sir, you will be so indulgent as to allow me space for a repetition of my words. I said, "Mr. Atherton adheres to his exploded formula $\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} = C$, and his Table is at once a demonstration of his fidelity and the absurdity of his formula. He has—

Ind. H.P.	Displacement. Tons.	Draft. Ft.	Speed. Knots.
1,000	17,000	20	6·88
1,000	28,000	30	6·16

"At 20 ft. draft of water the average area of transverse sections would be 875 ft.; the area of the midship section 1,400 ft. At 30 ft. draft of water the average area of transverse sections would be 1,441 ft., and the midship section 2,220 ft. (the average width between the 20 ft. and 30 ft. drafts in midships being 82 ft.) The resistance to a plane of 875 ft., at 6·88 knots per hour, would be about 117,740 lbs.; to a plane of 1,441 ft., at 6·16 knots per hour, would be about 155,858 lbs. I do not hold out the average of transverse sections as the absolute measure of resistance—it is modified by length and form; but I do offer the suggestion as sufficient to show *that Mr. Atherton's formula has misled him.*" Mark Mr. Atherton's candid reply to this. He adroitly diverts the attention of your readers from the discrepancy I quoted from his Table, and upon which alone I laid any stress, and, with simulated self-complacency, declares: "I see no occasion for 'G. J. Y.'s' denouncing the formula which I have adopted as an absurdity, especially in comparison with his own process of calculation, as described by himself in the following words:—'Really, my process, though a laborious one, has been so empirical that it is, after all, but little better than guessing.'" What appositeness is there in this? I did not denounce the Table because it was at variance with my "guess," but because it exhibited results which were at variance with each other. This he must have perceived. What does he deign to say to it? Not a word. "Silence is wisdom," said the cynical philosopher, and Mr. A. seems to have adopted the maxim. Well, I will endeavour to show him a reason or two why his formula should be denounced.

In the first place, I denounce it, because it has a sinister effect upon his own intellect, and endamages his reputation. I believe that, as a scientific man, he would have had a higher *status*, if he had never seen it. He servilely submits his judgment to its cramping influence. Will he pardon me for saying that the incongruity of the two statements I have extracted from his Table must have been obvious to him, if his mind had been unfettered by it?

Again, I denounce this formula, because it appears to me to be a sort of mathematical monster, which with inexplicable infatuation he has made his hobby, but which, nevertheless, is prolific of nothing but errors, the present blunder being its legitimate offspring. I lay aside the bantling for a minute or two to examine its mal-constructed parent, $\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} = C$. I have before said that V^3 is spurious, and $D^{\frac{2}{3}}$ absurd. The preface to the Government report of the "Results of Trials, &c.," states; "The resistance is, in the first of these columns, assumed to vary, *cœteris paribus*, as the area of the midship section; and in the last column *as the square of the cube root of the displacement*. None of these assumptions, however, *more especially the last two*, are absolutely correct, &c." I would suggest, as an emendation for the next report, "people may amuse themselves with the '*last two*,' but they are demonstrably so *incorrect* as to be useless."

In arguing this question with Mr. Atherton, a very cursory examination of the elements of this formula will be sufficient. He has not mystified himself with just enough of algebra to prevent him from distinguishing between truth and error when seen through a fog of symbols, and is not so profoundly imbued with "*philosophy*" as to conceive that a force of *one* pound will lift *four* pounds; or that it is futile to improve a steamer's form and diminish her

resistance, because, forsooth, you cannot thereby add an ounce to the pressure on the piston! I think, indeed, that he would hardly venture to defend his V^3 upon purely dynamic principles, one of the most rudimentary of which is, *that pressure will not give increased motion to a mass, if its resistance be increased in the same ratio as the pressure.* But a *fourfold* pressure upon a steamer, if applied in the most efficient direction, does cause her to move *twice* as fast: therefore the *absolute* resistance cannot have been increased fourfold, but (taking increased motion into account) as $\frac{4}{2}$. In any *finite portion of time* the amount of this resistance would be quadrupled, because it would be overcome through a double space. Thus the force expended *or work done upon the water* by the vessel, during *any* measure of time, is as $\frac{4}{2} \times 2 = 4$: that is, as V^2; so that the formula is *prima facie* erroneous, as being at variance with the dynamic fact upon which it is ostensibly based.

But waiving all considerations of a purely dynamic character, it behoves us to inquire whether it is absolutely necessary to apply mechanical power $= V^3$ when resistance has become $= V^2$. I assert that it is not. I do not say this is never done, or that it is not done frequently; but supposing the propelling instrument to be such that the engines do their maximum work, and the utmost possible effect is produced upon the ship, then it is known that increased pressure upon the pistons requires a re-adaptation of the propeller;—but I will not anticipate a discussion of the greatest practical importance, which will come on in due time. We must preliminarily determine the work at the bows; we shall get to the paddle-boxes and stern-post by-and-by.

In the interim, will Mr. Atherton condescend to read the following simple mechanical suggestions, and forgive their homeliness? V^3 had its origin in the following practically stated conceptions: a lighterman with his staff, pushing as hard as he can, moves a *light* lighter through 60 ft. in a minute, and walks 60 ft. on her gunwale. He then, doing his best, pushes a *loaded* lighter through 30 ft. in a minute, walking that distance. I daresay the man would stare if he were told that every ton added to his cargo diminished his labour, and that he had done twice as much work in the former case as in the latter! But this is essentially the cube theory. A man's strength is the pressure, and pressure × space is the essence of that theory. If a yielding substance were placed on the gunwale, deeper footprints would be found when the slower motion was produced. And we have yet to learn how dynamometrical indications, with the same amount of pressure upon the screw, may be affected by varied resistances and speed. Again, we are acquainted with persons who opine that if a horse, *doing his utmost* by himself, draws a barge with 30 tons in it 1 mile per hour, we have only to clap on three others with him (thus doubling the speed of the barge) *to make HIM do twice as much work!* They say, it is one horse mile in the first instance, and two horse miles in the second! The theory being that the animal moving his own body a mile is equivalent to his drawing a barge laden with 30 tons the same distance; and that although he did *as much as he could* when he pulled at *one* mile per hour, *he does twice as much* when he pulls at *two!* "For are not resistances as V^2—that is 1 : 4? and is not the space moved through 1 : 2—and, *ergo*, is not the work $4\ H \times 2 = 8$! Of course! give all the four quadrupeds an extra feed of corn! Once more. There is a very large vessel to be towed, and one of the ordinary tugs, with two engines, each 20 H.P., will move her at $1\frac{1}{2}$ miles per hour. Now we want to move her *twice as fast*. Would Mr. Atherton have FOUR TUGS or EIGHT TUGS to do it? I know what number he actually would have; but the oracle we now consult is his formula. The response is $V^3 = 8$.

EIGHT TUGS! Allowing for the power expended upon themselves, I think *four* would do it. Say the amount of steam-power in each tug is nominally 40 H.P. The engines work up to 80 indicated H.P. The difference between eight tugs and four tugs is $(80 \times 8 = 640) - (80 \times 4 = 320) = 320$ indicated H.P. Suppose we ascertain the power expended upon each tug for its own use by the formula. Mr. Atherton cannot object to that. Such tugs with full power have a speed by themselves of 9 miles per hour. What power will they absorb at 3 miles per hour? $\frac{3^3}{9^3} \times 80 = 2\frac{26}{27}$ indicated H.P.! This is ridiculous enough, but it is another sample of the absurdity of V^3. If four tugs will pull four times as hard as one, and thus overcome the resistance of the vessel towed, at a double velocity, they will do this for a given time, with an expenditure of power which is fourfold. True, they require power to move themselves, but certainly that would be but a small fraction of 320 indicated H.P.; besides, this ought not to be placed to the account of the towed ship. It would be tedious, as well as supererogatory, to go into the minutiæ of the power absorbed by the tugs. The portion transmitted to the tow-rope is all we have to do with. Here, then, is a broad fact, and I seriously and respectfully ask Mr. Atherton whether EIGHT TUGS or FOUR TUGS would be required to do the proposed work. His answer shall decide the question between V^2 and V^3.

We proceed to $D^{\frac{2}{3}}$—displacement raised to the power of $\frac{2}{3}$. This purports to be a measure of the resistance. Let us examine its pretensions. Suppose a 2 ft. cube, then $2^3 = 8$ will be its solid contents, and $8^{\frac{2}{3}} = 4$ is the area of one of its sides. So, if we take a 4 ft. cube, then $4^3 = 64$, and $64^{\frac{2}{3}} = 16$, area of side: this is one use of $D^{\frac{2}{3}}$. It also will produce numbers, or coefficients, in the ratio of the sectional areas of prismatic bodies, the linear dimensions of which are all respectively proportional to each other. Thus a parallelopiped, with a base, whose side $= 1$, and height $= 8$, will have contents $= 8$, and $8^{\frac{2}{3}} = 4$. Another of the same proportions, viz.: side of base 2, and height 16, will have contents 64, and $64^{\frac{2}{3}} = 16$; and 4 : 16 is the ratio of their bases, which we assume to be 1 : 4. But by what stolidity or perversion of mind can this be supposed to be a fit element of a formula for determining a steamer's resistance? Alter the proportion between length and base, and it at once ludicrously fails. Taking our second prism, and putting length $= 20$, breadth $= 2$, and depth $= 1{\cdot}6$, we still have solid contents $= 64$; and $64^{\frac{2}{3}} = 16$, as before. But in the former case we had sectional area $2 \times 2 = 4$; we now have $2 \times 1{\cdot}6 = 3{\cdot}2$. Will a transverse section of 3·2 encounter the same resistance as one of 4; or will the increased length from 16 to 20 make up for the difference in friction? It is preposterous!

Steamers have been lengthened, some forward, some aft, and one at least at both ends. Their resistance has in every case been diminished. The *Flying Fish* had a bow added to her; her speed was increased a knot per hour with full power, and with "half power," so called, she had the same velocity as before; but there were sixty revolutions with the original bow per minute, and only forty with the new one! Mr. Atherton does not doubt the effect of lengthening with improved lines the fore end of a steamer; but what becomes of $D^{\frac{2}{3}}$? When you lengthen, you increase weight, and displacement is thereby increased; *so that you get an increase of velocity where $D^{\frac{2}{3}}$ would indicate a diminution of it.* But then we are told the type of the vessel is changed.

Well, one can hardly say that Mr. Laird altered the "*type*" of the *Candia*. He cut her asunder, and introduced an additional 33 ft. 6 in. of midship body. Her displacement was increased from 2,520 to 3,090 tons. This must, by $D^{\frac{2}{3}}$, have appeared to increase the resistance in the ratio of 1 : 1·16; whereas the fact was found to be, as everybody knows, that her speed was not diminished a jot. Really I am unable to conceive of any rule more absurd *per se*, more opposed to rational induction from experiment, and more repugnant to common sense, than this same $D^{\frac{2}{3}}$. Displacement may be constant—the coefficient resulting from $D^{\frac{2}{3}}$ unvarying—while, by simply changing the proportion of length to sectional area, speed may be indefinitely varied. In good sooth, if this formula be used for *à priori* purposes, it will merely show that all vessels which are *exactly alike*, if propelled by the *same power*, will have the *same speed.*

If you have ascertained *displacement,* indicated H.P., and *speed,* of what use is the coefficient of this formula? Surely these data will enable you to determine the character of the ship much better without the involution and evolution of $D^{\frac{2}{3}}$ than with it.

To return to the Table. Is not the immersed body of the *Leviathan* at 30 ft. draft of water of a very different *type* from what it is at 20 ft.? Mr. A.'s oft-repeated declaration is against him. If the formula will only apply to vessels of the same type, it will not apply to the *Leviathan* light and loaded. 600 : 30 and 600 : 20 differ widely. Test the following three vessels by the formula and the formula by them:—

	Speed. Knots.	Displacement. Tons.	I.H.P.	Coefficient by formula.
No. 1	12	1,728	1,008	247
No. 2	12	1,331	847	247
No. 3	12	1,000	700	247

The formula makes these vessels to have exactly equal merit. Common sense, however—seeing that every unit of I.H.P. in No. 1 moves about $1\frac{3}{4}$ tons, in No. 2 above $1\frac{1}{2}$ tons, and in No. 3, $1\frac{3}{7}$ tons—very much prefers No. 1. And observe, the ratio of I.H.P. is precisely what $D^{\frac{2}{3}}$ would give. No more need be said about $\frac{V^3 D^{\frac{2}{3}}}{\text{I.H.P.}} = C.$

I will now requote Mr. Atherton's discrepancies, with the addition of areas of midship sections, and averages of the areas of transverse sections.

Ind. H. P.	Displacement. Tons.	Draft. Ft.	Speed. Knots.	Areas of Mid. Sections. Ft.	Average areas of Transverse Sections.
1,000	17,000	20	6·88	1,400	875
1,000	28,000	30	6·16	2,200	1441

I think there are but few engineers who would not at once pronounce these two lines of figures to be incompatible with each other. Using the common formula $\frac{V^2}{2g}$, we have, at 11·616 ft. per second (6·88 knots per hour), 2·0974 ft. = height of a column of fluid, the weight of which is the resistance; and at 10·4 ft. per second (6·16 knots per hour), 1·681 ft. = the height of a similar column. Taking 875 ft. and 1,441 ft. as the bases of the columns respectively, and sea water as the fluid, the resistance at 20 ft. draft, at the assumed velocity, would be about 117,000 lbs.; at 30 ft. draft, with the velocity assigned to that, about 155,000 lbs. Test this by the ordinary method employed by engineers; then 117,000 lbs. × 6·88 = 80,496,000, the work done in one case; and 155,000 lbs. × 6·16 = 95,480,000, the work done in the other. Yet the *same power is allotted to each!* I shall not denominate the above figures *knot-pounds;* they are (according to rule) relatively as the work done. At the deep draft it is nearly one-fifth more than the work done at the light draft, and Mr. Atherton for each allows 1,000 indicated H.P. This rule is not mine, and I will not for a moment contend that the average of sectional areas is an accurate measure of resistance: it is but a remotely approximate measure of it. But then both are in favour of the deep draft immersion, because the lines above the 20 ft. mark are less favourable to speed than those which are below it. I could quote from published Tables some striking proofs of the correctness of computing by the average area of transverse sections; and Mr. Atherton could, no doubt, cite from the same source as many disproofs. You may prove nearly what you please from reports of trials; I therefore spare myself and him the trouble. He is the only opponent I have confronted in this controversy who has favoured me with a kind and conciliatory expression, and therefore, on that account, as well as from a consciousness of the respect which is due to him, I beg him to be assured that I dissever his formula from himself in the opprobrium I express.

G. J. Y.

MECHANICAL SCIENCE.

To the Editor of The Artizan.

Sir,—"G. J. Y." has taken a "*long farewell*" of Mr. Mansel, which I presume may be accepted as an implied confession of an ineffectual attempt to produce conviction of the truth of the square theory. In my opinion, he has neither supplied the definition of his own, nor does he understand the basis of the cube theory, the imperative requirement pointed out by "Goosequill" in one of his able communications—a point of the utmost consequence in prosecuting any controversy to a successful termination. It was with pleasure, after wading through "G. J. Y.'s" rambling letter, that I perceived that Mr. Armstrong had again entered the lists as an advocate of the square theory, which he first proposed in your columns. It is now evident that the subject embraces the fundamental principles of mechanics, for, if the opinion of Mr. Armstrong is correct, the present practice of marine engineering (increasing the velocity of the piston to add to the power of the engine) may be safely termed the greatest blunder of civil engineering; for I believe there are vessels in the English Navy (high pressure) in which the velocity of the piston is upwards of 9 ft. per second for a speed of vessel under 10 knots; while in the *Rattler*, for the same speed, the velocity of the piston is under 4 ft.

With your permission, I will now attempt, with the assistance of Mr. A.'s last communication, to define the principles of both theories, and endeavour to point out what is required to bring the controversy to a satisfactory conclusion. The "*cube theorists,*" I may add the mechanical world, assert that the mechanical effect of force (foot-pounds) *is unlimited*, as expressed in the definition of power, viz., the product of the force and space passed over; while Mr. Armstrong asserts it to be a constant quantity, or the product of the retarding pressure and velocity. Surely such a diversity of opinion ought scarcely to occupy a moment's hesitation in appealing to well-authenticated facts, instead of the principles of *vis viva*, *mass*, and other irrelevant matter, as a proof of the truth of their principles: the invariable practice pursued by Mr. Armstrong in all his communications. Now the six trials of the *Flying Fish*, produced by Mr. Armstrong in his last communication may safely be termed an ample confirmation of his own peculiar views; but allow me to suggest, that the trials of a single vessel might only be a coincidence, *not a fact*. For this purpose Mr. A. ought to exhibit a number of vessels, with the variation in the velocity of the piston as great as possible; then, if the speed of the vessel is merely in the proportion to the force employed, the conservation of the mechanical effect of force is Nature's law, and the definition of the general principle of mechanics. On the other side, it will be indispensable to the "*cube theorists*" to point out where Mr. Armstrong's mode of analysis is incorrect. To myself, he simply makes the velocity of the piston, "*the small fraction*" representing the form, and the value of the coefficient of friction; the unknown quantities, therefore, having all the other terms given, the value of the unknown terms, I presume, is represented in the two columns, "ratio of speeds and forces;" or the equation may be expressed thus for the *Flying Fish*:

$$\text{Vel.} \times \cdot 97 = \sqrt[2]{\frac{\text{Force}}{\text{Mid. Sec.}}}$$

or

$$\text{Vel.}^2 = \frac{\text{Force} \times \cdot 94}{\text{Mid. Sec.}}$$

In conclusion, I beg to suggest to the cube theorists their reading of the laws of motion, so as to be placed in opposition to those of Mr. Armstrong.

A LOOKER ON.

ON CALCULATING THE PROPELLING POWER OF THE ENGINES OF STEAMSHIPS.

To the Editor of The Artizan.

Sir,—By my letter of the 15th March (The Artizan, No. clxxxiii.), I desired to recognize the good service done by Doctor Eckhardt in bringing forward the scale of resistance as affected by the angles of the stem and stern lines of ships, and illustrating the application thereof by reference to the *Leviathan*, with a view, I presume, of rendering the experience to be gained from the future performance of that vessel available for testing the applicability of this table of resistance to steam-ship practice. The principle of the system of calculation thus adduced by Dr. Eckhardt will, I have no doubt, be practically available when the coefficients of its application to steam ships shall have been practically ascertained; but which essential requirement does not appear to me to have been yet accomplished.

As to deducing the propelling power required to overcome any given amount of resistance at a given speed, it was in consequence of Dr. Eckhardt having himself deduced 996 H.P. (page 54), as the probable requirement to propel the *Leviathan*, at 30 ft. draft, at the speed of 16 miles per hour, a result which I could not arrive at from Dr. Eckhardt's figures, compatibly with any recognized system of estimating or calculating the H.P. of marine engines, that I desired, by my letter of the 15th of March, to know the measure or definition of the UNIT of power (H.P.) on which Dr. Eckhardt had based this result.

We are now favoured (The Artizan, No. clxxxiv.), with Dr. Eckhardt's further letter on this subject, confirming his former calculation as to the *Leviathan* at her 30 ft. draft, and moving at the speed of 16 miles (knots) per hour, having to encounter a resistance equal to 552,955 lbs.; but now it appears that Dr. Eckhardt regards the H.P. deductions of his former letter (996 H.P.), as expressing only "the first part of the required power;" and he now adduces, as the result of his calculations, 2,600 H.P., assuming the same to be "in accordance with the indicated H.P. provided by Mr. Brunel." On this point, I beg to remark that 2,600 H.P. is the reputed *nominal* H.P. of the engines of the *Leviathan*; and that I imagine Dr. Eckhardt is in error in thus denominating the engines provided for the *Leviathan* by Mr. Brunel as 2,600 indicated H.P., seeing that marine engines in this country are always expected to be capable of working up to an indicated H.P. far above their nominal H.P.:—for example, the mail packets *Banshee*, *Llewellyn*, *Caradoc*, *Vivid*, *Garland*, *Violet*, *Onyx*, *Princess Alice*, and *Undine*, averaged an indicated H.P. upwards of four times their nominal H.P.; and the engines of the *Elfin*, as originally fitted by Messrs. Rennie, worked up to an indicated H.P. amounting to six times their nominal H.P.; and the general average of the indicated H.P. of marine engines is probably three times their nominal H.P. After these precedents, it seems probable that the 2,600 H.P. engines of the *Leviathan* may have been designed for working up to 12,000 indicated H.P. In fact, "nominal H.P." by which marine engine power is generally bought and sold, advertised and officially recorded in the "Mercantile Navy List", has no legalized signification whatever as a measure of working power. It is only the unit of power, denominated indicated H.P., that has any definite signification as a measure of power, this unit being recognized as equivalent to raising 33,000 lbs. weight 1 ft. high in 1 minute of time; but singularly enough, this unit, though the only definite and recognized measure of engine power, is never referred to commercially as the base of marine-engine contracts. Of late, however, since this anomaly has been exposed, I understand the commercial interests of Russia and other continental states have commonly adopted the plan of making the indicated H.P. capability of marine engines a condition of their contracts. China and Great Britain may probably, in course of time, follow the example.

Perhaps Dr. Eckhardt, not having rightly comprehended this truly British stolid paradox, of denominating engines 2,600 nominal H.P. that are intended to work up to 12,000 indicated H.P., may have been misled in his application of these delusive terms, and he will doubtless more readily perceive the difficulty that I have felt in regard to his mode of deducing the propelling power from the calculated resistance, by my exemplifying what I take to be the received method of deduction. Admitting, therefore, not as a matter of fact (for the coefficients of the scale of resistance have not yet been adjusted to steam-ship practice), but of assumption, that the *Leviathan*, at 30 ft. draft, and at the speed of 16 knots per hour, will be opposed by a resistance equivalent to 552,955 lbs. weight, it appears to me that the net effective power by which the *Leviathan* attains that speed will be equivalent to a force of 552,955 lbs., moving at the rate of 16 knots, or 97,344 ft. per hour, being equivalent to 552,955 lbs. raised 1,622 ft. per minute, or equivalent to 896,893,010 lbs. raised 1 ft. high per minute, which, divided by 33,000, gives 27,179 indicated H.P. effective power; and to produce this effective power would require a gross indicated H.P. of no less than one-third in addition, amounting to 36,238 gross indicated H.P. to be exerted by the engines. This I presume to be the legitimate deduction from Dr. Eckhardt's figures, and it is about three times the working power (12,000 indicated H.P.) that may be reasonably expected from the engines of 2,600 H.P. (nominal) with which the *Leviathan* is supplied; whereas, by the formula adopted by me, the index number of dynamic duty being taken at 215·5, and the displacement at 28,000 tons at 30 ft. draft, the gross indicated H.P. corresponding to the speed of 16 knots per hour would be 17,567 indicated H.P., or only about one-half the power deduced, as above, from Dr. Eckhardt's calculated resistance.

I may here observe that, by the prospectus of the *Leviathan*, it does not appear that a higher speed than 15 knots per hour was originally contemplated; and, by my Table (The Artizan, clxxxii., page 66), it appears that this speed (15 knots) may probably be realized by the engines working up to 12,000 indicated H.P., the draft of the vessel being such that the mean displacement of the ship do not exceed 21,160 tons, which, as appears by drawings of the *Leviathan* lately published, will be the displacement at 26 ft. draft, the displacement at 30 ft. draft being 26,000 tons.

As to my own calculations, I assign the numeral 215·5 (the coefficient realized by *Rattler*) as the coefficient or index number of dynamic duty which may be expected to be realized by the *Leviathan*, not under the impression that it cannot be surpassed by any type, for vessels are said to have reached the coefficient 250, but because, judging from the type of form as respects draft of water in proportion to beam, and displacement in proportion to immersed surface of hull, and experience of the coefficients actually realized by vessels under approximately similar conditions, excepting as to size—for example, the *Banshee*—I regard the coefficient 215·5 as the highest number which analogy, so far as I know, admits of being applied to the *Leviathan*, for the highest coefficient realized by the *Banshee* was, I believe, 214·4. It is also to be observed, that this coefficient (215·5) is not expected to be realized unless the hull of the vessel be in good seaworthy condition; a slight degree of foulness produces a perceptible effect in lowering the index number of dynamic duty; indeed, so sensitive are vessels in this respect, that an ordinary twelve months' fouling of an iron ship in port may be expected to reduce the index number 20 per cent., in comparison with what would be produced by the same type of build if coppered and clean; or even 40 per cent., if subjected to the rapid fouling that usually occurs to iron vessels in a tropical climate.

As to the formula itself, $\frac{V^3\, D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C$, which has been adopted—not invented—by me, based, as it is, on the formula $\frac{V^3 \text{ Mid. Sec.}}{\text{Ind. H.P.}} = C^1$, I have regarded this formula as being usefully approximate for determining the mutual relation of displacement, power, and speed, which may be expected in vessels of similar type, and for approximately discriminating between the relative dynamic merits of vessels of different type, and estimating the loss occasioned in any ship by reason of foulness and other defects of condition and management; but, strictly speaking, I have not regarded this formula as theoretically precise, and I have expressed the views which I hold thereon in various publications,

especially in a Paper read by me at the Cheltenham Meeting of the British Association, and now embodied in the volume of "Transactions of the Association for the year 1856," pages 429 and 438, in which I suggested that the depth of the centre of gravity of the midship section of the immersed body below the surface of the water should be made a function of the formula, and that, in consequence of this being omitted, I regarded the formula only as approximate, and capable of amendment. I have adopted this formula, and made it the base of a system of "Mercantile Steam Transport Arithmetic," as set forth in my essay "Steam Ship Capability," 2nd edition, simply because, so far as I have had the means of practically testing it, I have found the construction of the formula to be such as may be approximately relied upon for the above-mentioned purposes, assuming that the index number to be applied in any particular case for adjusting the capabilities of an intended ship shall have been determined by experience of the index number, which has been actually realized on the trial of some vessel of analogous type of build. It is to be expected that the future career of the *Leviathan* will afford the means of testing the unlimited application of the formula, or of amending its construction, whereby it may still more accurately develope the mutual relations of displacement, power, and speed.

I cannot close this letter without noticing the further important service rendered to naval architecture by Dr. Eckhardt's letter (The Artizan, clxxxiii, page 92), whereby the relative resistances encountered by the convex bow and the concave bow of double flexure, denominated the wave line bow, are definitely set forth by numerical comparison in a manner which leaves this much-talked-of subject no longer a prey to mystery and to the unbounded licence of merely opinionative assertion. I may further observe that the results of Dr. Eckhardt's mathematical deductions on this subject correspond, in a remarkable degree, with Gore's experiments on the resistance of floating bodies, embracing the double flexure bow, as set forth in Steel's "Naval Architecture," 2nd edition, page 108, published in "1812," but apparently forgotten in 1850. Double flexure lines in the run of vessels have been ordinarily adopted, but the resurrection of late years of the double flexure bow, under the new denomination, "Wave Line," seems to have taken effect as a phantom, to which the most visionary properties have been attributed, and which has scared the nautical world into as great a degree of gullibility as was formerly achieved by the *Flying Dutchman*.

I am, Sir, your most obedient Servant,

Chas. Atherton.

Royal Dockyard, Woolwich, May 18th, 1858.

VIS VIVA.

To the Editor of The Artizan.

Sir,—Your correspondent "G. J. Y." writes: "What a controversy is this!" and truly it is a pitiful one: a clever gentleman, with utterly mistaken notions of the nature and relation of mechanical principles, obstinately maintaining a discussion on a subject involving those principles by modes of argument alike unsuited to the subject, his opponents, and himself. The subject demanded earnest intelligence; his opponents, other reply than ridicule founded on misrepresentation; and his *wit*, a "basis of fact to employ it upon," otherwise it degenerated into mere license; and for the improperly assumed motto "*Nemo me impune lacessit*," ought to be substituted Don Quixote's observation to Sancho Panza: "*Peor es meneallo*," which appears to represent the case under consideration with singular felicity. About six months ago "G. J. Y." wrote: "*Vis vivâ*, this *ignis fatuus*, which has seduced so many from the path of common sense ——" furnishing an illustration; but somewhat abated, he now writes: "It is easy to follow mathematicians in their course.... we find $\left(\frac{w}{g}\right) v^2$ called *vis viva*, and $\frac{1}{2}\left(\frac{w}{g}\right) v^2 =$ accumulated work; this is utterly unobjectionable. The objection is to giving the principle a generalization beyond its legitimate limits:" but, at the same time, offers explanations which show that he utterly fails in perceiving, in any case, the nature of the principle which he thus concedes. Previous to analyzing his notions, I have to remark on another subject, and, in connection, offer explanations on the grounds of the reservation found in some works on mathematical mechanics.

"G. J. Y.'s" statement in the December number: "'Earnshaw,' used at Cambridge, says the principle of *vis viva* is not true if any of the bodies move in a resisting medium," I at once challenged, and maintain that "Earnshaw, used at Cambridge," says nothing of the kind. The work answering to that description is known as "Dynamics, or a Treatise on Motion," of which several editions have been called for, and which has been too generally appreciated to be *scarce;* while the book to which "G. J. Y." appears to have referred, you describe as "Dynamics, or an Elementary Treatise on Motion," published in 1832. "G. J. Y." took the trifling liberty of assuming that Cambridge mechanicians accepted a proposition because it happened to be found in a superseded horn-book. To add to its weight, he indicated the source of his quotation by a false description, and met with the most appropriate refutation possible. The apparent objection in the quoted *elementary* work finds no place, and has its refutation supplied by the later authoritative work of the same author—that to which the title, "used at Cambridge," can alone be held to apply.

I have said apparent objection, for an intelligent examination of the submitted extract will show that it applies, not to the interpretation of the principle of *vis viva* employed in applied mechanics for the investigation of motions *of* and *in* resisting mediums, but to the application to those motions of the principle of the *conservation* of *vis viva*, in its purely mathematical sense. In this case the medium itself is not considered as forming a part of the system, or, if admitted, no notice is taken of physical changes in its condition. The present discussion is on a question of applied mechanics, in which we have to do with the principle of *vis viva* as we find it in nature, and not with its mere scholastic restrictions.

The principle referred to as that of *vis viva* is analytically stated by the equation:

$$\Sigma\, m v_2 = C + 2\, \Sigma \int m f(X\,dx + Y\,dy + Z\,dz):$$

and its strict meaning is: the sum of the masses of the particles of any moving system respectively multiplied by the squares of their velocities is equal to C, the sum of the like products at any assumed epoch, together with twice the algebraic sum of the work done by all the various forces acting on the system since that epoch.

Earnshaw ("Dynamics," second edition, 1839) states that the above equation "is of such extensive application in the various branches of mechanical philosophy;" and goes on to explain how to apply it: "*If the system move in a resisting medium, the resistance must be reckoned as an impressed force.*" The reason is obvious. If the system move in a resisting medium, that medium opposes forces to the said motions, and work must be expended in overcoming those forces. In any case whatever, work expended being estimated in the second member, renders the application of the above principle perfectly general. The principle of the *conservation* of *vis viva* is founded on the same equation and interpretation, with the addition, that, if employed in the restricted scholastic sense, to suit the mathematical analysis, the forces in the second term of the second member must, severally, fulfil the following condition: *by motion of the points of application of the various forces, in any direction, work being performed, by reversing the motion and returning to the original position, an equal amount of work must be restored.* To illustrate this distinction: if a weight be raised from rest, through a given space, work must be expended upon it; but this will be strictly restored when the weight, reduced to rest, has returned to the original level. In work spent on friction or motions in a resisting medium, work is not restored when the motion is reversed. The same with collisions of imperfectly elastic bodies: these are changed in structure; in this change work is expended, and we know that, to put them in their original state, so far from getting work restored, we would have to expend more. It may be further noted that, in reality, the two latter are cases in which work is expended upon molecular action, corresponding to friction among the particles.

Here, then, we have *vis viva, power, mechanical effect,* or *work*, expended on a particular class of resistances; in applied mechanics, by the principle of *vis viva*, we recognise and endeavour to estimate its amount.

The scholastic reading of the *principle* of *conservation of vis viva* takes no account of work thus expended; it consequently fails when applied to such a problem; and also fails to interpret the principle of *conservation* of *vis viva* of the Universe, which, consonant with all experience, appears to be: *vis viva*, of which the measure is that product of force and space which we call *work*, and of which the unit is one foot-pound, is definite in amount, and indestructible in *essence*. It may be developed from a latent source, but never created; expended, and, it may be to appearance, changed, but never annihilated; and hence time, as an element, can in no way enter into it. "G. J. Y.'s" explanations in reference to *vis viva* are all based on the fallacy of substituting time for space; they are opposed to the present state of mechanical science, and are, at least, unwarranted, if not directly contradicted, by the past. And, though he would fain make it appear that he sees something very ludicrous in my remarks, mistaken effrontery can scarcely be recognised as a reply to the following extracts from the "Mécanique Industrielle" of the greatest living authority on applied mechanics, M. Poncelet. Fairly translated ("Fundamental Principles," page 75), we find:—"The expression *living force*, employed to designate the product $\frac{P}{g} \times V^2$, being likely to lead many persons into error, it is proper to remark that, according to our view, it is not, properly speaking, a force any more than the quantity P × H, which, in general, we name *quantity of action, quantity of work*: it is merely the result of the activity of a motive force or pressure, *expressible in weight*, which has been employed, during a longer or shorter time, to overcome the inertia of the matter of the body .... *Living force*, in truth, ought to be the *dynamical effect* of the motive force, or rather the double of that effect." In reference to this, I remark that *dynamical effect* is stated to be Monge and Hachette's name for *work*, and that time is obviously mentioned in the sense that it may have any value whatever, as it does not enter the question. Further, in reference to this (page 47), "It happens ordinarily that, for the sustained work of motors, we only consider the length of the path described during a second, taken for unit of time, in order to have small numbers to consider; this length being also that which is most readily adopted to express the velocity of movement, we see that the work during a unit of time is thus found really measured by the product of an effort, or weight, and a velocity. It is this which causes confusion of mechanical work with momentum (*quantité de mouvement*), although their signification and their measures are fundamentally very different." Again: "It is in this manner that the idea of time is introduced into the notion of mechanical work, although, investigated in its more absolute relation, this is truly independent of it." Smeaton (1776) as explicitly states: "Time, properly speaking, has nothing to do with the production of mechanical effect .... a mechanical power, therefore, properly speaking, is measured by the whole of its mechanical effect produced, whether that effect is produced in a greater or lesser time." Poncelet thus points out the mistaken notion by which Smeaton's statements are perverted to a meaning which he, in the above, expressly disavows.

I now proceed to refute a few other obvious errors. "G. J. Y." asserts "*weight, motion*, and *time*, are the elements of 'work.' A plane driven through water 10 ft. overcomes the *inertia* of 10 ft. of water. Here *inertia* is the substitute for *weight;*" and he writes down two cases, in effect:—

Motion.		Inertia.		Work.
10 ft.	..	10	..	10 × 10 = 100;
20 „	..	20	..	20 × 20 = 400.

Had he understood the third law of motion, as illustrated by Atwood's "celebrated machine," and mathematics, he would have seen that the "*inertia*" in the two cases varied as the square of and not as the velocities. Must it be again pointed out to him that a plane moving with velocity 2, in any small time, encounters twice the weight of water that is encountered in the same small time by a similar plane moving with the velocity 1? and that, as on the *same* weight, the pressure acting during that time to overcome its inertia, must be as the velocity generated in that time, on the doubled weight and doubled velocity the total resisting force which the "*inertia*" of the fluid opposes to the motion of the planes are as 4 to 1; hence it is that the weights which, falling uniformly, drag similar planes through water with velocities 2 and 1, are as 4 to 1; or, as we say, the resistance varies as the square of the velocity. Again, in the same time, the weight 4 descends through the space 2, and the weight 1 through the space 1; the works done by gravity, in the two cases, are therefore as 8 to 1. But, as "G. J. Y." feels bound to concede that the works done by gravity on the constant falling weights are equal to the works expended on their respective resistances, these latter are also as 8 to 1, or in the ratio of the cubes of the velocities. Next, "G. J. Y." states, "a foot-pound of the retardation at 10 ft. velocity is not a unit of the same value as a foot-pound of the retardation at 20 ft. velocity." What is the variable element? Does his Atwood's machine not teach him that the force of gravity upon a lb., falling at 10 ft. velocity, is the same as when it falls at 20 ft. velocity, in accordance with the conceded principle, forces produce their full effects in the direction of their action, whatever be the velocity of the body on which they act; and, as the only other element in the respective ft.-lbs. is the 1 ft. of space, does this become shorter or longer when described with a doubled velocity? Or is this another specimen of the implied "sense" which, with the aid of "all the laws of dynamics," enables him to write nonsense? But again, in reference to this, he advanced a proposition in language admitting of several constructions. I took the one most favourable to his intelligence, but showed it to be irrelevant to his deduction. He now indicates his own construction, and, in doing so, refutes his proposition. I adopt his notation: C, and c, are two planes drawn through water, with velocities of 10 ft. and 20 ft. per second respectively, by 20 lb. constantly-falling weights attached directly to the planes. It is agreed that the work done by gravity is equal to the work expended on the resistance: hence,

$$20 \times 10 = C\,(10)^2 \times 10;$$
$$20 \times 20 = c\,(20)^2 \times 20;$$

and, as he quite correctly points out to me, $C = 4c$.

Again, as "resistance is as velocity ^{2} × area,"

$C\,(10)^2$ being the resistance of the first,
and $c\,(20)^2$ " " second,

substituting, in the last, for c its derived value, it becomes $C\,(10)^2$, exactly the same as the first. Now the proposition was that the resistance, in the second case, must be "reduced," whereas his algebra proves them to be identical! As to "why the lb. passes through the ft. twice as fast in the one case as in the other," he may find a satisfactory answer by applying "Mr. Moseley's words" to the "incipient motion." "G. J. Y." imagines that he discerns an "under-current of error," and to expose it states: "the same pressure may drive a vessel 8 miles in an hour that drives another 2, and the expenditure of coals be nearly alike in both cases:" all of which I freely admit, and even carry his illustration a little farther. Suppose the two-mile vessel run hard and fast aground! one might still manage to burn as much coal and develop the same power in the cylinders, as with the vessel sailing at 8 miles. But the immediate question is, to propel the same vessel at different speeds, what expenditure of power do natural laws demand? not the proportion of power that may be wasted in different vessels. "G. J. Y." writes about "the immense amount of power" which the engineer bestows "upon the inertia of his machinery," which proves very clearly that he does not entirely comprehend what power *is*, or he would have known that the engineer got it all back again. Also, in reference to slip or power bestowed on the "yielding fulcrum," it is our interest to make this a minimum; but as "G. J. Y." cannot perceive that the "cube" is the necessary law, in the case of a plane drawn through water by a uniformly falling weight, where this and other conflicting elements are avoided. On any mechanical theory or argument, his opinion, as to "enormous absurdity," has, of course, the weight attached to a considerable degree of smartness, but likely to leave the matter in precisely the same state as he found it.

In conclusion, "G. J. Y." corrects "one other mistake": M. Comte's book is anti-metaphysical! but as "positive philosophy" is not applied mechanics, I think it rather "extraneous," and I still imagine that M. Comte *is* a *metaphysician*, though, in his peculiar province, distinguished by clearre views than the generality of his fellow philosophers. I have however to acknowledge a far worse mistake. I accepted "G. J. Y.'s" construction of a quotation from this author when I ought to have observed that a term used, "Rational Mechanics" (an evident translation of the French term "*Mécanique Rationelle*"), showed that M. Comte referred to the more abstruse *theoretical* mechanics, and not to *applied* or *practical* mechanics, with which alone we have to do. I have really no quarrel with M. Comte, for I cannot conceive that he could discover "*à priori* suppositions," or absence of "basis of fact," in insisting on a proper appreciation of the *fact* that a *lb.* is not a ft.-lb., and that the one could not be compared with the other, more especially when we find his illustrious countryman, M. Poncelet, writing: "It is not possible to confound the effort or simple pressure which a motor exercises on a body with its mechanic work, or this work with the movement, actual or acquired, of the body."

Govan, Glasgow. Robert Mansel.

ON BOILER EXPLOSIONS.

To the Editor of The Artizan.

Sir,—Having experienced great pleasure in the perusal of Mr. Strong's most excellent letter on "Boiler Explosions and the causes to which they are attributed," which appeared in your number for January, I shall feel obliged if you will allow me to say a few words corroborative of his views.

The theory that "explosive gas" is generated in boilers by the decomposition of the water, through the plates having become over-heated from want of water, is one which has found much favour amongst *quasi* scientific men, but which I heartily concur with Mr. Strong in thinking ought rarely, *if ever*, to be ascribed as the cause of explosion.

I have had many years' experience in boilers (I was formerly managing partner of the late firm Sharp, Roberts and Co., and later of the firm Roberts, Fothergill and Dobinson), and have investigated the causes of many explosions, often as witness on inquests, &c., but have *never yet found a single instance* in which it was not perfectly clear that sufficient cause existed for the accident without attributing it to the explosive properties of hydrogen, or any other gas. In my opinion, what is ascribed to "explosive gas" is in reality due to the action of steam under high pressure.

It is remarkable how inadequate boilers often are to the pressures at which they are worked, and in many instances had not conclusive evidence been adduced to show that they had in reality sustained such pressures, I could not have believed that they would have borne *half* as much. To illustrate this, I may mention that about twenty years ago I examined the ruptured boiler (and have a drawing and description still by me) of the locomotive "Patentee," which burst whilst ascending the Whiston incline of the Liverpool and Manchester Railway. In this case the engine was used as a bank engine, and as both engines were found insufficient to carry the train up the incline, a draw-chain, weighing about a dozen pounds, was attached to the end of the safety-valve lever, but without attaining a higher speed than a walking pace. The firebox was the widest I ever saw on the narrow gauge; notwithstanding which it had only two longitudinal stays (the usual practice being to put about a dozen; I never used less than thirteen), and in turning up the edge of the fire-door plate to form angle iron, to which the crown plates and sides were attached, it had been hammered so square on the outside that the inside was cracked *halfway through*. My wonder is that the boiler bore even the ordinary pressure. In this explosion a remarkable peculiarity was evinced. It was found that the after-part of the firebox being blown out, the engine then went about a quarter of a mile up the incline at a *considerably increased speed*; the steam rushing out behind urging the engine forwards, on the same principle that a rocket is propelled.

A second instance, very similar in principle to the above, is that of the "Irk," which blew up at the Miles Platting station of the Lancashire and Yorkshire Railway, some six or seven years ago. The engine was standing in the shed when the top of the copper firebox burst, and the steam issuing downwards, caused the engine to be propelled through the roof of the shed and to perform a somersault. It was attempted to be shown that steam was incapable of such powerful action, and that in this case "explosive gas" was the agent; but in my opinion, it was clearly through excessive pressure that the explosion occurred. I may add that, a short time previous to the accident, a regulation had come into force by which the enginemen found their own fuel; and being no doubt aware that high-pressure is cheaper than low-pressure steam, had endeavoured to economise and so had gone too far.

Amongst the many causes to which boiler explosions are attributable, malformation of the safety-valves, flues, &c., absence of proper lead plugs, defective workmanship, and excessive pressure, may be ranked as the principal.

Safety-valves are rarely properly constructed, the lap of the valve over the seating being generally so great that a partial vacuum is formed by the rush of the steam, and the valve is prevented from rising more than a minute quantity (not more than $\frac{1}{20}$ or $\frac{1}{15}$ of an inch). In fact, were the lap of the valve a little larger than is generally the case, the valve would not rise more than this limited quantity, *even if it were not weighted at all*. This is a fact which I discovered in 1824. M. Clement des Ormes, of Paris, has generally received credit for the discovery, but it was I who communicated it to that gentleman.

This objection would be removed, were valves constructed as in the accompanying sketch, in which it will be seen that the overlap of the valve is considerably greater than is usual; but the outer portion of the seating being

recessed, the bearing surface is comparatively small. It will be seen that the seating surrounds the valve like a ring, which will have the effect of preventing the steam from issuing freely until the valve has risen above the ring, and consequently is beyond the range at which a partial vacuum is formed.

I consider that the use of the lever and spring balance is a very objectionable mode of weighting the valve, inasmuch as the arms of the lever being of such unequal lengths, for every unit the valve rises, the balance must be lifted four or five, consequently causing the steam to attain a much higher pressure than that at which it was adjusted to blow off. As an illustration, I may mention that in the year 1834 I saw a locomotive boiler tested with a mercurial gauge; the valve was adjusted to blow off at a pressure of 50 lbs. per sq. in., but the pressure, as indicated both by the mercurial gauge and the spring balance, rose to 90 lbs. per sq. in. before the steam was let off as rapidly as generated.

Many explosions are attributable to excessive pressure caused by the recklessness of the enginemen, &c., who risk not only their own lives, but those of the persons about them, the valve being often much more heavily weighted than they will acknowledge. Subsequent experiments tended to show that the boiler of the locomotive which blew up a few years ago at Longsight, near this city, must have withstood a pressure of *about* 300 *lbs. per sq. in.* before rupturing. In this case the engine, with a good fire under the boiler, was standing in the shed with the steam *blowing off* at 63 lbs. per sq. in., and as the noise annoyed the men whilst at breakfast, the valve was screwed down tight upon the seating and remained in this position for about *twenty-five minutes* before an explosion took place.

I perfectly agree with Mr. Strong in thinking that explosions from want of water would be *entirely* prevented by the *proper* use of the lead plug, *i.e., sufficiently large, and renewed monthly;* but I think that the present system of bushing the boiler with brass to receive the lead is decidedly bad, inasmuch as by destroying the continuity of the metal, its conducting power is impaired. This was clearly shown in a boiler, the cause of whose explosion I investigated some four or five years ago. I found that in both flues the plates surrounding the lead plugs, to the extent of 6 ft. by 1 ft. 3 in., had been heated to *redness;* unable to withstand the pressure, one of the flues gave way, extinguishing its fire; the other being relieved, its fire remained until it spent itself; *yet in both flues I found the plugs entire, except that through the centre of each a hole of barely* 3-16*ths in. diameter had been formed.*

I would suggest that the lead plug be inserted into the crown plate itself (as in accompanying drawing), and that it be made with a taper copper core, say of about 5-8ths in. diameter, passing through its centre, and projecting downwards about an inch beyond the lead, the surrounding lead to be about 1-4th in. thick. The advantage of this description of plug would be that when the copper became overheated, the lead would at least melt sufficiently to allow the core to fall out, and a comparatively large passage for the water being opened, the fire would be immediately extinguished, even if the whole of the lead were not melted, which I think, however, would be the case.

Many explosions take place through the malformation or defects of the boiler, and I would strongly condemn the use of elliptical flues; nor should the boilers be made too long, as not only do they generate less steam per ton of coal, but the flues are much more liable to collapse. It is important likewise that *competent* persons be employed to repair, &c., boilers, otherwise deplorable results may ensue. A short time ago I investigated two cases, in both of which the owners, desirous of working with increased pressure, had consulted *engineers* (?) as to the best means of strengthening their boilers, but in both cases the boilers repaired according to this advice were *weakened*, not strengthened.

In conclusion, permit me to say that I agree with all Mr. Strong's remarks, and shall be glad to see another letter from that gentleman in continuation of the subject, which is far from being exhausted.

I remain, Sir, yours respectfully,

Richard Roberts, C.E., Consulting Engineer.

30, *Brown-street, Manchester.*

ANGULAR CAM CHUCK.

To the Editor of The Artizan.

Sir,—I should perhaps have made known the following some six years back, when it was devised by me for a certain purpose, had I then good reason to think it new, as I now have, from lately getting the opinion of one whose name ranks high in the engineering profession.

It might be called the Angular Cam Chuck. As I do not wish to take up your valuable space, I shall merely name some of its leading features, namely, its applicability to,—

Fig. 1.

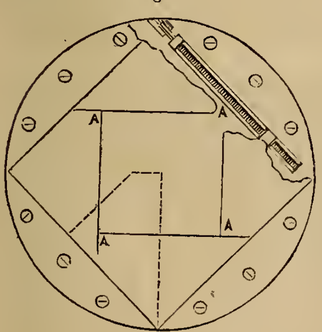
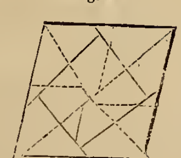


Fig. 2.



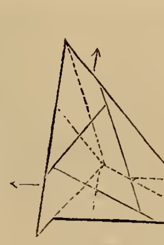


Fig. 3.

1. Universal chucks: if used for a surfacing chuck, four studs should be fixed at the parts marked A, Fig. 1 (a die chuck).
2. Change of direction of motion, as Fig. 3.
3. Variable openings for optical purposes, supply pipes, &c.

It will work with eight or ten sides.

The wedges are indefinitely nearly flush with the segments they work against, which are screwed on the body of the chuck: a plate (not shown), with suitable opening is fixed over all by screws passing through the segments; if well made, an adjusting arrangement is not required.

I am, Sir, yours obediently,

John J. Dowling.

DIMENSIONS OF NEW STEAMER.

DIMENSIONS OF STEAMERS "HABANA" AND "CARDENAS."

Built by Charles H. and William M. Cramp, Philadelphia; Engines by Merrick & Sons, Philadelphia.

	Ft.	In.
Length on deck	180	0
Breadth of beam	30	0
Depth of hold at do.	11	0
Length of engine and boiler space	28	0
	Tons.	
Tonnage, Custom House	560	

Number of engines, 2; kind of ditto, square and vertical geared, $2\frac{3}{5}$ to 1; kind of boilers, horizontal tubular; diameter of cylinders, 3 ft. 4 in.; length of stroke, 3 ft. Diameter of screw in *Habana*, 8 ft. 8 in.; in *Cardenas*, 8 ft. 6 in.; length of screw, 2 ft.; pitch of screw, 14 ft.; number of blades of screw, 4. Number of boilers, 2: length of ditto, 12 ft. 5 in.; breadth of ditto, each, 8 ft. 7 in.; height of ditto, exclusive of steam drums, 9 ft. 6 in.; Number of furnaces, each boiler, 3; breadth of ditto, 2 ft. 3 in.; length of fire-bars, 6 ft.; number of tubes or flues, 128; internal diameter of ditto, 3 in.; length of ditto, 8 ft.; heating surface in square feet, 1,120; diameter of chimney, 4 ft. 6 in.; height of ditto from grate, 40 ft.; boiler pressure in lbs. per square inch, 20; cutting off, from commencement of stroke, 1 ft. $1\frac{1}{2}$ in.; contents of bunkers in tons, 20: consumption of coals per hour, half a ton; draft forward, 9 ft.; draft aft, 9 ft. 6 in.; average revolutions per minute, 34.

Frames, 13 in. × 6 in., and 21 in. apart; masts, 3; schooner rigged.

Intended service, Coast of Cuba.

DIMENSIONS OF STEAMERS "HUNTSVILLE" AND "MONTGOMERY."

Hulls built by J. Westervelts and Sons, New York; Engines by Morgan Iron Works, New York.

	Ft.	In.
Length on deck	200	0
Ditto at load-line	175	0
Breadth of beam (moulded)	29	0
Depth of hold	10	4
Depth of hold to spar deck	18	4
Area of immersed section at load draft of 13 ft.	330 sq. ft.	
Hull / Engine-room	840 tons.	

Description of engine, vertical inverted direct; ditto boiler, return tubular; diameter of cylinder, 56 in.; length of stroke, 3 ft. 6 in.; diameter of screw, 14 ft. 3 in.; length of screw, 1 ft. 9 in.; pitch of screw, 21 ft.; number of blades of screw, 4. Number of boilers, 1: length of ditto, 15 ft. 2 in.; breadth of ditto, 16 ft.; height of ditto, exclusive of steam chimney, 16 ft. Number of furnaces, 4; breadth of ditto, 3 ft. 4 in.; length of grate bars, 7 ft. 6 in.; number of tubes above, 238; ditto arches below, 4; internal diameter of flues above, $3\frac{1}{4}$ in; length of ditto above, 12 ft.; ditto arches below, 4 ft. 6 in.; diameter of smoke-pipe, 5 ft. 2 in.; height of ditto, 22 ft.; draft forward and aft, 13 ft. Date of trial, April, 1858. Maximum pressure of steam, 25 lbs.

Frames moulded, 14 in.; sided, 12 in.; 24 in. apart from centres, and strapped with diagonal and double laid braces, $4\frac{1}{2}$ in. × 5-8th in.; depth of keel, 12 in.; independent steam, fire, and bilge pumps, 1; masts, 3; rig, square forward.

Intended service, New York to Savannah.

DIMENSIONS OF STEAMER "MANJOOR."

Hull built by Paul Curtis, Boston, Mass.; Engines at Atlantic Works, Boston, Mass.

	Ft.	In.
Length on deck	189	0
Breadth of beam (extreme)	37	0
Depth of hold to spar deck	12	8
Length of engine space	54	0
Hull / Engine-room	785 tons.	

Kind of engines, oscillating; ditto boilers, return flued; diameter of cylinders, 42 in.; length of stroke, 4 ft.; diameter of screw, 12 ft.; length of screw, 4 ft.; pitch of screw, 26 ft. expanding to 30 ft.; number of blades of screw, 4; number of boilers, 2; length of ditto, 32 ft.; breadth of ditto, 8 ft. 6 in.; height of ditto, exclusive of steam chests, 9 ft. 6 in.; cubic ft. in steam chests, 210; number of furnaces, 4; breadth of ditto, 3 ft. 6 in.; length of fire bars, 7 ft. 2 in.; diameter of chimney, 5 ft. 6 in.; height of ditto above steam chest, 26 ft.; area of immersed section at load draft, 325 ft.; load on safety valve in lbs. per sq. in., 25; gross indicated power, at $\frac{1}{4}$ cut off, 534; heating surface; 3,127 ft.; contents of bunkers in tons, 200; consumption of coals per hour, 1,400 lbs. Date of trial, April 1, 1858. Draft forward and aft, 9 ft. 6 in., average revolutions, 38; speed in knots, 10.

Frames, moulded, 15 in.; sided, 12 in.; 24 in. apart. Number of bulkheads, 3; independent steam, fire, and bilge pumps, 1; masts, 3; rig, barque.

Intended service—Russian Government, as a transport on Amoy river.

Remarks—Three upper strakes of bottom plank, an edge outside. Hull coppered.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as

possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we sball be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury Street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

CANADA has adopted a *decimal currency*. The coins have been prepared in this country, and consist of 5, 10, and 20 cent. pieces.

LORD DERBY has consented to make an immediate grant of £200 to the aged descendants of the late Henry Cort, who introduced great improvements in the smelting of iron.

BRITISH ASSOCIATION.—The opening meeting is to be held at Leeds, on Wednesday, September 22.

THE ROYAL SOCIETY has commenced the very important and extensive undertaking of compiling a catalogue of all the memoirs contained in the "Transactions of scientific societies and scientific periodicals since the year 1800."

NATIONAL ASSOCIATION FOR THE PROMOTION OF SOCIAL SCIENCE.—The next annual congress is to be held at Liverpool.

It is proposed to establish a WORKING MAN'S COLLEGE AT SALFORD.

THE SCOTTISH INDUSTRIAL MUSEUM.—The Secretary to the Treasury has intimated to the Lord Provost of Edinburgh that a vote of £10,000 for the museum will be included in the estimates.

MR. GEORGE WALLIS has resigned the head mastership of the Birmingham School of Art. He is succeeded by Mr. Rainbach, formerly master of the Cork School of Design.

COMPETITIVE EXAMINATIONS.—Lord Derby has signified to the Society of Arts, that he will allow of four candidates from that society to compete this year "for such clerkships, and other similar situations, as may be under his lordship's control."

THE ART-TREASURES EXHIBITION BUILDING, at Manchester, has been sold in "lots," by auction. The entire roof, down to the gutters, of the Ancient Masters' gallery—saloons A, B, and C—a range which included 432 lineal feet, extending from the eastern end to the transept, having 48 feet span, and covering 2,304 square yards of floor, was purchased for £350, by Mr. Lamport, shipbuilder, Workington, who will erect it in two portions, as sheds for shipbuilding.

THE KING AND QUEEN IRON WORKS, Rotherhithe, have been greatly damaged by fire.

ONE-HALF of the casting-shed at Lord Granville's blast furnaces has been destroyed by fire.

THE WHOLE OF BELGIUM is suffering extremely from want of water.

VICTORIA CLOCK TOWER.—The new "Big Ben" bell has been re-cast at the foundry of Messrs. Mears, Whitechapel-road, and hung temporarily for trial, and rung, its note being E. The bell is perfect in tone, and in its casting, and is tastefully ornamented with Gothic figures and tracery in low relief.

GRANITIC BRESCIA STONE COMPANY.—Capital £100,000. The Company has been formed for purchasing the rights of a patentee, and his works at East Greenwich, for £20,000; one-fourth in cash, the remainder in shares. Testimonials from various well-known engineers and contractors accompany the prospectus.

A MACHINE BELT-SAW, for cutting deals, 50 ft. long, 4 in. wide, has been made by Messrs. Atkinson and Pearce, Union Lane, Sheffield. Space of tooth, three-eighths; thickness, 18 wire gauge.

MESSRS. THOMAS FIRTH AND SONS, of Sheffield, are beginning to use cast steel, instead of wood, for the helves of their tilt and forge hammers.

LARGE ORDERS FOR IRON RAILS AND PIPES are brought by every mail from Australia. One contract with the South Australian Government, for the supply of water-pipes, is to the extent of £80,000 or £90,000.

A NEW PATENT-LAW AMENDMENT BILL, having for its object the reduction of the amount of the present fees to about one-half, has been introduced into the House of Commons. Its second reading was negatived without a division.

MR. D. EVANS, foreman of the smiths at the Eastern Counties Railway Works, Stratford, has disposed of a patent for improvements in fire-boxes in boilers for £1,000.

IMPROVEMENTS IN THE MANUFACTURE OF IRON.—A highly important treatise on this subject has recently been published from the pen of Mr. S. B. Rogers, of Nant-y-glo (as advertised in another column of this journal), to which we call the earnest attention of all interested in the manufacture of iron and steel.

BESSEMER'S PATENTS.—The new works of Messrs. Bessemer and Longdon, at Sheffield, are approaching completion.

PHILADELPHIA IRON MANUFACTURES.—The "Philadelphia North American" states, that in that city and neighbourhood there are over ten thousand persons engaged in iron manufactures, whose products of industry amount to 12,857,000 dollars annually.

BEDFORD.—Some NEW IRON WORKS are in course of construction here, to be called the Britannia Iron Works. The area of ground covered by the extensive works at present in hand is 7,731 sq. yds., but this forms only a portion of the ultimate erections. The new building is divided into six bays, or roofs, which comprise the following—namely, that on the north, the first bay, will include brass-foundry, bending-furnace, boiler-house, coal-stores, sand-shed, men's closets, &c. Comprised in the second bay will be the foundry, 180 ft. long by 50 ft. wide, pattern stores, 50 ft. by 30 ft., and fitting-shop of similar dimensions. In the third bay is the engine-room, and the lathe and machine shop; the latter of which is 180 ft. by 50 ft., together with the pattern-maker's-room, and stores for castings. The south comprises the fourth, fifth, and sixth bays, within which will be arranged the smithery, 180 ft. by 150 ft., the roofs of which are supported on cast-iron columns. The buildings are in course of erection by Messrs. Lawson and Freshwater, of Bedford, from designs by Mr. R. Palgrave, of London, architect. The estimate of the contractors for those portions of the works now nearly completed was £10,000.

MR. BRAY'S TRACTION ENGINE, of which a description was given at page 99 of the present volume, has been successfully worked at Woolwich, for transporting heavy ordnance. It was charged with a 68-pounder gun, weighing 112 cwt., which it conveyed through the gates of the Royal Arsenal, down the Plumstead-road, over the steep acclivity of Burrage-hill, returning by the descent of Sandy-hill to the Arsenal. The speed rarely exceeded 2½ miles per hour—about the average pace of a cart-horse; but it continued a similar pace against the breast of the hill. The descent was also cleverly arranged, the engine appearing to be under the most perfect control of the helmsman and engineer.

A model of the TURBINE WATER WHIM, on Schwanbrug's system, used for the purpose of raising minerals at the Oberesneues-Geschrey mine, at Freiberg, has been placed in the Government School of Mines.

BARON CHARLES DUPIN has just placed in the Conservatoire des Arts a power-loom that weaves silk by electric mechanism.

COAL AND IRON MINES IN PRUSSIA.—The coal mines have made great progress. The production of iron has greatly increased. The Rhenish provinces and Westphalia are now rivalling with Silesia.

THE great Rocky Mountains contain beds of bituminous coal.

THE SEWAGE IN LONDON.—The preliminary report of the Royal Commission appointed to inquire into the best mode of distributing the sewage has just been laid on the table of the House of Commons. "Convinced by the representations of Mr. Goldsworthy Gurney," says a summary in the "Times," "that the mere diversion of the sewage will not purify the Thames from its present foul condition—the effect of past accumulations—the Commissioners recommend the immediate execution of the embankment scheme propounded by the Metropolis Improvement Commission of 1844. Advanced terraces being constructed, continuous on the surface, but affording convenient entrances to inner basins for the wharfs above London Bridge, reservoirs are to be formed in the embankments adjacent to the mouths of the existing sewers, into which all the sewage is to be received and deodorised, and from which—the purified water being first allowed to flow into the river—the precipitated matter will be pumped into the country, or to the sea. The reservoirs and apparatus are to be beneath the surface, and, consequently, invisible, so that no nuisance whatever can be apprehended. The subsidiary parts of the scheme are the adornment of the river, the relief of the streets by the terrace carriage-ways between London and Westminster, and the connection by railroad of the existing termini on the southern shore. The cost of the entire works is estimated at £3,250,000, exclusive of any approaches which may be formed in connection with the new thoroughfare." The Report is signed, Essex, Henry Ker Seymer, Robert Rawlinson, J. Thomas Way, J. B. Lawes, T. Southwood Smith, John Simon, Henry Austin.

A DEPUTATION on the subject of a decimal coinage had an interview with the Right Hon. J. W. Henley and the Earl of Donoughmore, on the 14th inst., at the Board of Trade.

COLT'S REVOLVERS.—Experiments have recently been made with these weapons at Washington, U.S. The board report that they are superior in every respect to all others. Drawings, with full sized details, of Colt's, Adams's, and Parker's repeating pistols will be found in our volume for 1852.

SOUTH AUSTRALIA.—COAL has been discovered in the Bothwick ranges, extending from Nuyt's Archipelago to Mount Hope. It is said to be a kind of anthracite, suitable for steam purposes.

FROM a Paper just presented to the Academy of Sciences, by M. Commines de Marsilly, it appears that the total quantity of coal consumed in France is nine millions of tons, of which five millions come from the north—viz., Charleroi, 900,000; Valenciennes, 800,000; Pas de Calais, 300,000.

LADY BENTHAM, relict of the late Brigadier-General Sir Samuel Bentham, died on the 18th inst. Her labours of love in making known to the world her husband's many and great inventions, in which he anticipated the principal of the improvements and alterations which have since been effected in the dockyards, and in the construction of the ships of the Royal Navy, have rendered her name deservedly well known. Her contributions have often enriched the pages of THE ARTIZAN.

THERE is now exhibiting at Chelmsford Market a windlass for ploughing and cultivating land by means of a wire rope, the windlass being driven by an ordinary portable engine. The mode of working is said to be quite on a new principle, patented by Mr. Eddington, of Springfield. The windlass, which was manufactured by Messrs. Everett and Taylor, of Chelmsford, consists of a strong framework, containing two drums, and is supported on large wheels. When used for ploughing, or when moved from one farm to another, the portable engine is drawn up an incline on to the top of the framework, and there drives the windlass direct from the fly-wheel by means of a strap.

REBUILDING OF CHRISTIANA.—Vessels which proceed thither in ballast, will find it to their advantage in carrying cargoes of bricks and stones, which will find a ready sale.

A FATAL EXPLOSION OF FOUL AIR has occurred in an ironstone pit at Wingerworth, near Chesterfield.

LATE INTELLIGENCE FROM THE SUSWAP COUNTRY, VANCOUVER'S ISLAND, confirms the report of rich gold discoveries on Fraser's and Thomson's rivers.

FOUR NEW BLAST FURNACES, for the production of pig iron, have been erected at Jarrow by the Messrs. Palmer, iron shipbuilders. The blast, instead of being produced with the ordinary single-beam engine, is the result of the operation of five single engines, each of 60 H.P., and driven at a speed of about seventy revolutions per minute. The furnaces are each 60 ft. in height from the ground to the gangway, and 12 ft. from the gangway to the summit, or a total height of 72 ft. from the ground; and they are 17 ft. across the boshes. It is expected that they will produce from 800 to 1,000 tons per week. The engines of the furnaces have been built by Messrs. J. B. Palmer, and are driven by ten boilers, worked at a high pressure.

IT is said that the Admiralty have directed South Wales steam coal to be used henceforth for naval purposes. An Aberdare firm is now engaged to supply 20,000 tons of coal for Government steamers.

THE CLEVELAND IRON FIELD.—Mr. Hawkshaw, C.E., expresses his opinion confidently that in a short time Cleveland will be the scene of as extensive operations in the iron trade as either Staffordshire or South Wales.

THE NAUTILUS DIVING APPARATUS (which was illustrated in THE ARTIZAN, Vol. 1855, p. 36), has been submitted to the scientific men of France, and warmly approved of by them.

DECIMAL MEASURES AND WEIGHTS.—Mr. Simon Holland's scheme is founded on the sixteenth of an inch as a basis. The old sixteenth becomes the tenth of the new inch. The surface measures are the squares of the measures of length, and their decuples. The measures of bulk are the cubes of the measures of length, and their decuples. The measures of weight are derived from making the new gallon and a quarter of water to be a new stone of 10 lbs. By this scheme the new grain and liquid measures would be exactly four times those of France, and the weights exactly half; and, therefore, like those of the German Customs Union. The new cwt. would be 110 lbs., old; 10 new bushels equal to 11 old; the new bushel, therefore, weighing as many new lbs. as the old one old lbs. 10 square new fathoms equal to an old rod of brickwork, and old land perch. 70 new miles equal to a degree of the meridian. The Mint-price of gold would be £6 5s. per new oz.

IRONWORKS IN NORTHAMPTONSHIRE.—There are at present only three blast furnaces in this county, but it is very probable that before very long more will be erected. The present works are at Heyford, near Weedon, where there are two furnaces and also a foundry, where upwards of 100 tons of railway chairs are made weekly for the London and North Western Railway Company. The remaining furnace is at Wellingborough, and is only a small one, where 50 tons of cold-blast iron are produced weekly. At Heyford, each furnace averages 80 tons per week of good melting pig iron. The iron made at these works during the past six months cannot be excelled as hot-blast iron, although as yet it is comparatively little known. It is suitable for any description of casting, and combines two very important properties—namely, "toughness with softness." It is peculiarly suitable for large machinery castings, and, in fact, any description of work where strength and soundness are required. A bar cast of equal proportions of No. 3 and No. 4 Heyford iron, measuring 2 in. by 1 in., and placed at a bearing of 3 ft., laid on the flat side, sustained a weight of 1,590 lbs. before breaking. The ironstone used at these works is procured from open pits, near Blisworth, which are being worked by Mr. George Pell, one of the proprietors of the Heyford Ironworks. The stone is of a very rich character, and averages in working a realisation of 40 per cent. The stone is not calcined before being put into the furnace, as is usually the case, but is thrown in just as it comes out of the pits. It is very easily fused, requiring a gentle mild blast while in the furnace. It is in contemplation, we believe, to erect a furnace where no blast engine is required at all. If this succeeds, the

saving in fuel, &c., will be immense. There is a small forge at the town of Northampton where 50 tons of malleable scrap iron are produced weekly, and, having no competitors in this line, the proprietors are reaping a rich harvest. The only desideratum to this county is the absence of coal, none having as yet been discovered in any portion of the county. A shaft was commenced some time ago near the town of Northampton, at a village called Kingsthorpe, but the undertaking was abortive, no coal being found, although a very great depth was explored.

SPECIFICATIONS AND INDEXES OF PATENTS are to be deposited for inspection in a room to be provided for the purpose in the New Town Hall, Leeds.

NEW SOUTH WALES.—THE PRESENT PATENT LAW gives great dissatisfaction to the colonists, and it is thought that some efforts will shortly be made to remedy the evil.

THE GREAT BELL for the clock tower of the New Houses of Parliament has been re-cast at the foundry of Messrs. Mears, Whitechapel Road.

THE HOUSE in which SIR ISAAC NEWTON was born, at Woolsthorpe, near Grantham, is about to be pulled down, and it is reported that a scientific establishment is to be erected on the site.

PHOSPHORUS has replaced arsenic for poisoning purposes in France. Of 86 cases in 1851, chemical matches supplied the phosphorus employed.

RAILWAYS, &c.

RAILWAY ACCIDENTS.—By a recent report by the officers of the Board of Trade it appears that nine-tenths of these catastrophies arise from collisions of trains, and that in almost every case they are caused by criminal neglect.

THE TRENT VALLEY ACCIDENT.—In consequence of this accident it has been suggested that all our locomotive engines should be furnished with a guard, similar to those used by our Transatlantic cousins, and called "cow-catchers." This contrivance picks up any animal that may be in the way, and throws it off to one side.

THE total number of miles of railroad authorised by the Legislature in 1857 was 674, and of these 19 miles were abandoned.

METROPOLITAN.—The section from the Great Western to Farringdon-street is to be constructed first at an estimated cost of £540,000. It is not intended to construct the section from Farringdon-street to the Post Office at present.

THE BOARD OF WORKS has determined to oppose the Victoria Station and Pimlico Railway Bill.

GREENWICH TO WOOLWICH DIRECT.—A meeting has been held in favour of a line from the Greenwich branch of the South Eastern, near Deptford Creek, passing thence across the principal street of the town to the Park, and thus form a junction with the main line of the North Kent at the Charlton station.

SHEERNESS DOCKYARD.—The Lords of the Admiralty have directed the attention of the authorities at this dockyard to report upon the desirableness of having a branch railway into the dockyard, to be connected with the Sheerness and Sittingbourne line.

NORTH WESTERN RAILWAY.—Oxford, Banbury, and Buckinghamshire Branch.—The foundation of a stone bridge about two miles from Oxford, carrying with it nearly half of the brick arch.

EAST KENT.—This line is to be extended from Strood to Strand, which will make it the shortest route to the Continent by Dover, avoiding the angle at Reigate.

SPALDING AND HOLBEACH.—The rails are now laid; the station-works progressing. It is expected that this line will be opened in June.

THE HERTFORD AND WELWYN line has been opened for traffic.

THE LYMINGTON BRANCH of the Dorcester railway is to be opened during May.

The line from DARMSTADT TO MENTZ is to be inaugurated on the 9th June.

EXETER AND EXMOUTH.—Length of proposed line, 1 mile 22 chains. The steepest gradient is 1 in 100. Estimated cost, £15,000. Land required, 13½ acres. Mr. Tolmé, engineer, was examined in support of the Bill. Committee satisfied of its fitness.

FORMARTINE AND BUCHAN.—The length of the main line, 27 miles 7 furlongs 148 yards; of the extension to Peterhead, 9 miles 6 furlongs 120 yards; of the extension to Fraserburgh, 12 miles 2 furlongs; and the branch to Ellon, 2 miles 4 furlongs 185 yards. In support of the Bill—Mr. B. H. Blyth, Mr. E. Blyth, Mr. Hawkshaw, engineers. In opposition—Mr. J. Willett, Mr. T. T. Mitchell, and Mr. J. E. Errington, engineers. Committee satisfied of its fitness in an engineering point of view.

CORK AND KINSALE JUNCTION.—The proposed line is 9¾ miles in length. The population of Kinsale numbers 6,000, exclusive of 1,000 military. The estimated cost of this line is £45,000.

PARIS, LYONS AND MEDITERRANEAN.—The lines belonging to the company consist of two distinct undertakings: that connected with the direct line from Paris to the Mediterranean being one, and that forming what was called the Bourbonnais line the other. In the former the works of the several branches are going on regularly. It is expected that the section between Besançon and Belfort will be opened about the middle of June, and that from Marseilles to Aubergne, on the Toulon branch, in September. The two great tunnels between Marseilles and Toulon are pierced throughout, and the whole of the line will be completed by the spring of 1859.

CAEN TO CHERBOURG.—The earthworks are nearly finished on the entire line. The last line of rails is being fixed. The great metal bridge over the river Vire is carried on with great activity, and the other bridges over the Tante, the Douve, and the Madeleine, are commenced.

THE CITY OF TOLEDO having resolved to present 70,000 piastres to the first person who should take a locomotive into that city, M. Salamanca took charge of the first locomotive which arrived there, and received the sum.

BELGIUM.—LICHTERVELDE TO FURNES.—This line has been opened. It is 21¼ miles long; was commenced January 10, 1857, and finished May 1, 1858, and has seven stations, exclusive of Lichtervelde.

THE SECTION OF THE WESTERN RAILWAY OF SWITZERLAND, between Cappet and Morges, a distance of 32 kilometres (20 miles), has just been opened.

RUSSIA has consented to three lines of railway between the Black Sea and the Caspian, all of them starting from Tiflis.

BLACK SEA RAILWAY AND KUSTENDJIE HARBOUR COMPANY.—The object is to make a short line of 39 miles, from Tchernavoda, on the Danube, to the Port of Kustendjie, on the Black Sea, and thus to save 200 miles of tedious navigation to the dangerous embouchure at Sulina. It was at one time proposed to effect the junction by means of a canal. Most of the land has been granted by the Turkish Government.

EUPHRATES VALLEY RAILWAY.—The report that this scheme had been abandoned has been officially contradicted.

EAST INDIA RAILWAYS.—There are six companies, viz., the *East Indian* from Calcutta to Delhi, with branches from Burdwan to Raneegunge, and from Mirzapore to Jubbulpore, 1,400 miles. *Eastern Bengal*, Calcutta to Ganges, at Koostre, near Pubnah, 130 miles, being the first section of a line to Dacca, with a branch to Jessore, which, when completed, will form the basis of a system for Eastern Bengal. *Madras*, from Madras to the western coast at Beypore, 430 miles, and from *viâ* Cuddapore and Bellary to meet a line from Bombay at or near the river Kristna, 310 miles. *Great Indian Peninsula*, from Bombay to Callian, 33 miles, with extensions north-east from Jubbulpore to meet the line from Mirzapore, with a branch from Pomrawutter and Nagpore, 818 miles, and south-east *viâ* Poonah and Sholapore to the Kristna river, to meet the line from Madras, 357 miles. *Scinde and Punjaub*, from Kurrachee to a point on the Indus at or near to Kotree, 120 miles, and from Moultan to Lahore and Umritzur, in the Punjaub, 230 miles. *Bombay, Baroda and Central India*, Bombay to Surat, Baroda and Ahmedabad, 330 miles.

EAST INDIAN.—The works in the south Beerbhoum district are making good progress. The Soane Bridge is to be recommenced immediately.

CALCUTTA AND SOUTH EASTERN.—This proposed line will be 28 miles in length, and, according to Col. Kennedy, "will have a very large traffic, and may be completed in a year and a half, at a cost of about £5,000 or £6,000."

BAHIA.—Mr. Vignoles, after a personal survey of the line, has estimated the entire expenditure at £1,400,000; and Mr. Watson has contracted to construct the line and carry out all the works according to these estimates.

TELEGRAPH ENGINEERING, &c.

THE ATLANTIC CABLE.—It is said that the new machinery for paying out the Atlantic cable has been inspected and approved by some of the most eminent mechanical engineers. A limited number of scientific persons, whose attention has been drawn to this subject, will be permitted by Government to go out in the *Agamemnon* to witness the submergence of the cable.

THE SHIPS composing the squadron for paying out the Atlantic cable will make an experimental trip of from six to ten days. The great attempt will be made about the 10th of June.

HULL is to be the great intermediate station of the Transatlantic and British and Irish Telegraph Company, for the transmission of messages between America and the continent of Europe. A four-wire cable is now being laid in the neighbourhood of Hull for this purpose.

EXPERIMENTS HAVE BEEN RECENTLY MADE, with a view of increasing the rapidity of working signals through the length of the Atlantic cable. The result shows that more than one submarine cable will be required to do all the business likely to be transacted between this country and the New World.

IT IS SAID that a new Company is in course of formation, for the laying down of a second electric cable to America from Plymouth, *viâ* Cape Finisterre, Lisbon, and the Azores, to Boston, U.S., or to the Island of Bermuda, and thence to Cape Hatteras, in North Carolina. Length, 4,000 nautical miles.

The submarine cable between PORTLAND AND ALDERNEY will not be much above fifty miles long. Cherbourg can be effectually watched from the neighbourhood of Alderney, and when the cable is laid down, instant communication can be given to all parts of England of any movement of the French fleet at Cherbourg. The cable could be easily extended from Alderney to Jersey and Guernsey, and a large portion of the French coast could then be watched.

FRANCE.—The Commission appointed to consider the claims for compensation of Mr. Morse, whose system of electric telegraphing has been adopted in France, has recommended that the Government should give him 400,000 francs indemnity.

MR. HENLEY has recently made a number of experiments upon the Atlantic cable at his own expense, with a view of perfecting a very simple and beautiful magneto-electric machine, by which a current is transmitted greater in intensity, though much less in quantity than the ordinary galvanic current, and thus the liability of the wire to become charged is considerably reduced. The immense advantages which a magneto-electric machine possesses over an ordinary battery are of almost incalculable importance. It is always ready, can be used anywhere, at any time, and by any person, and, above all, is no expense beyond the first cost of making it; in fact, the difference between Mr. Henley's machine and an ordinary battery is as great as between the electric and old semaphore telegraphs. It consists of an ordinary large permanent magnet, between the poles of which a soft iron magnet, with its coils of secondary wire, is fixed. By this arrangement it is necessary only to deflect the keepers of the magnet to produce an equal current at all velocities, and either in one direction or alternately backwards and forwards. The magnet is 2 ft. 10 in. high, and consists of thirty plates of the finest steel, ¼ in. thick and 4 in. broad. The soft magnet is formed of forty-four soft iron plates, in a mass of 3 in. broad and 2 in. deep, and of the same height as the permanent magnets. The secondary coils for producing the current in the poles of these magnets contain each 25 miles of the finest silk-covered wire, or 100 miles for the four magnets. With this machine already eight words per minute can be sent through the cable in its present condition, and, of course, the words can be transmitted with greatly increased rapidity when the cable is laid out in a straight course, for no position could be more unfavourable for transmitting signals than that in which the wire is at present stowed—in huge coils one over another.

TELEGRAPHIC COMMUNICATION WITH INDIA.—Capt. Pullen, R.N., has reported to the Admiralty very favourably on the proposed Red Sea line, concerning which some injurious reports had been circulated. He concludes his report by saying—"I think no place can be better adapted for laying a telegraph cable than the Red Sea. There certainly is the choice of routes, and throughout, on either shore, a soft bed may be got; the water is deep, though not more so, or even so much, as where other cables have been laid, except, perhaps, in the middle, and all we know of that yet is certainly of a nature to cause no injury. In the vacant spots within the entrance, &c., I should hardly imagine that very great depths would be found."

MILITARY ENGINEERING, &c.

ENFIELD SMALL ARMS' FACTORY.—The sum of £352,583 has been expended here between January, 1854, and the present time, viz.: for buildings, £91,618; machinery, £68,653; stores, £48,692; salaries, £7,048; wages, £135,132. 26,739 musket rifles (pattern 1853), made by machinery and complete, were delivered into store up to the 31st of March last; and parts of arms and materials, equal to some 10,000 finished rifles, are in various states of progress.

HEAVY ORDNANCE.—Up to the present time there have not been produced any successful castings for heavy ordnance at the new Royal Standard Gun Foundry, Woolwich Arsenal. Orders have, therefore, been given for a supply of no less than 600 of the largest class of siege guns from the Low Moor and other foundries.

MESSRS. W. CUBITT AND CO. have nearly completed, in the Gray's Inn Road, a large manufactory for Messrs. W. and C. Eley, patentees of improved cartridges.

ONE of Whitworth's thirty-two pounder cast-iron polygonal bore rifle guns burst, May 11, at Shoeburyness, during some experiments before the authorities.

MARINE ENGINEERING, SHIPBUILDING, &c.

During the month of April THE NUMBER OF WRECKS on the British Shores reported was 142.

ROYAL NAVY.—There are now building in the royal dockyards thirty-six screw steam vessels. Aggregate armament, 1,960 guns. Horses power of engines, 19,650.

AGENTS OF THE BRITISH GOVERNMENT have visited Baltimore for the purpose of purchasing three million feet of ship timber, which will be cut from the mountainous regions of the Baltimore and Ohio Railroad.

THE "PRINCEZA DE JOINVILLE," a fine paddle steam-ship, by Messrs. J. and R. White, of West Cowes, for the Brazilian Government, was launched May 7th. She is intended for conveyance of the mails, specie, &c., between Rio de Janeiro and Rio Grande. The builders guarantee her speed at not less than 12 knots per hour. Draught, when laden, 7 ft. 4 ins.; launching draught, 4 ft.; length between perpendiculars, 198 ft.; breadth, 31 ft.; depth, 18 ft. 9 in.; tonnage, 927. Engined by Messrs. Maudslay.

HER MAJESTY'S SHIP, "MARLBOROUGH," 131 guns, has made a trip since she was commissioned, for the purpose of testing her machinery. Length between perpendiculars, 245 ft. 6 in.; length of keel for tonnage, 206 ft. 4 in.; extreme breadth, 61 ft. 2¼ in.; breadth for tonnage, 60 ft. 4½ in.; breadth moulded, 59 ft. 6¾ in.; depth in hold, 25 ft. 10 in.; burden, 4,000 tons; horse-power, by Maudslay, 800 tons. She is fitted with a new kind of screw, the invention of the Messrs. Maudslay, "intended," the "Times" correspondent informs us, "to compete with Griffiths'."

THE apparatus for obtaining superheated steam, recently introduced by Mr. D. Patridge, inspector of machinery in Woolwich Dockyard, having been specially ordered by the Lords of the Admiralty to be fitted on board Her Majesty's troopship *Dee*, employed on particular service, has been tested, under the superintendence of Mr. Taplin, assistant to the

chief engineer of the yard. The *Dee* left Woolwich at 1 o'clock on the 17th ult., and steamed down the river, returning on the evening of the 18th at 7. Captain Sasse, a Swedish naval officer, accompanied the vessel, by permission of the Admiralty, in order to witness the trial, the result of which was reported as follows :—The economy in fuel alone amounted to from 25 to 30 per cent., and, together with the additional power obtained by the lesser quantity of coals, realises an advantage of upwards of 38 per cent. in favonr of the use of superheated steam. The consumption of coals with superheated steam amounted to about 980 lbs. per hour, and with plain or ordinary steam to about 1,370 lbs., showing a difference in the consumption of fuel, in each successive hour, of 390 lbs. The nominal power of each engine is 100 horses.

North of Europe Steam Navigation Company. — Three of the cattle steamers have been purchased by a company to run between Denmark and Lowestoft.

Isle of Man Steam Packet Company.—A new steamer, the *Douglas*, has been built at Glasgow.

The Red Sea Steam Navigation Company, established under the patronage of the Viceroy, has commenced active operations. A boat, purchased in England, is on its way round the Cape. Unfortunately, one of the steamers, the *Suez*, purchased in France by M. Lesseps, has been totally lost in the roadstead of Jaffa.

France.—Trials are to be made of some new flat-bottomed steamboats, on a new system. These boats are intended to be used as transports on the Chinese rivers, and, if necessary, to make an attack upon Pekin.

The French Imperial Yacht Eugenie is to be broken up.

Greece is about to increase her navy.

Messrs. McNabb and Co., of Greenock, have received an order from the Greek Government to construct three pairs of engines.

Two steamers have just been built in the United States for trading between the Amoor river in Russian Asia, China, and California. The "Scientific American" informs us that "one, named the *Manjoor*, was built at Boston ; the other, named the *Japanese*, at New York. The latter is 1,400 tons burthen, the former 1,000 tons. Their engines are strong, plain and compact, and designed for effective service, not show. They are both propellers, and have made their trial trips, running at the rate of from 8 to 10 knots an hour easily. Their model is good, and under sail alone they have the speed of clipper ships. Their draft of water is comparatively light, as there are many shoals in the Amoor river. A great quantity of machinery, such as saw-mills, is to be taken out in these vessels." The particulars of the *Japanese* are given at p. 143 of the present Number.

The Strike of the Sunderland Shipwrights has terminated, the men accepting the reduced wages—4s. per day.

South Shields.—The *Vianna*, a large iron steam-vessel, has been launched from Mr. T. D. Marshall's building yard. In launching, the *Vianna* ran into the *Rosendale*, a large barque, carried away her stern and left the blade of one of her screws in her quarter. The barque began to fill, and was got on to the middle ground, when she sunk. The *Vianna* was not much injured.

Iron Shipbuilding in Greenock —Since 1840, Messrs. Caird and Co. have built iron vessels with an aggregate tonnage of 49,874. Since 1852, Messrs. Scott and Co., Cartsdyke, have launched 22,302 tons ; and Messrs. John Scott and Son, 9,252 tons : and since September, 1854, Messrs. R. Steele and Co. 11,581 tons.

Collins' Atlantic Steamers.—A memorial has been presented to the United States Government asking for aid to this line.

We have to chronicle another terrible Steam-boat Conflagration, attended with the loss of about twenty lives. The steam-boats *Ocean Spray* and *Hannibal City* were *racing* on the Mississippi on the 22nd of April, when the former was losing the advantage. Resin, and then turpentine, were freely thrown in the furnaces and over the coals. By some means the barrel of turpentine ignited, and in attempting to cast it overboard, the burning fluid spread all over the deck and poured down the hold. The vessel was immediately in flames.

Montreal and Quebec Ocean Line. — The *Nova Scotian*, built by Messrs. Denny, of Dumbarton, has arrived in the Mersey. She is the largest vessel ever built at Dumbarton, being 2,200 tons, with 300 ft. length of keel, a breadth of 37 ft. 9 in., and depth of 28½ ft She is full barque rigged, and has only one funnel. Owners, Messrs. Allan, of Glasgow, and Messrs. Allan and Gillespie, of Liverpool.

The Admiralty Authorities have ordered that all troop, transport, and convict ships chartered by the Government are in future to be fitted up, at the expense of the owners, with ventilating apparatus to exhaust the foul air from the vessel's hold and between decks.

Schiele's Patent Fans have been applied with success for the ventilation of the cattle steamers belonging to the City of Dublin Company.

Southampton, May 18.—Four handsome steam vessels, built by Messrs. J. and R. White, of Cowes, for service in the Turkish waters, were handed over to the proper authorities. Of the four vessels, two are paddle-wheel steamers, built for the Imperial Ottoman Company, and to ply on the Danube. They are of uniform size, their dimensions being as follows :—Length over all 170 ft., beam 24 ft., depth 9 ft. 6 in., builders' measurement 484 tons, H.P. of engines 100 (nominal). The screw steamers are for the Turkish Government, and are of the following dimensions :—Length over all 79 ft., beam 16 ft., depth 7 ft., builders' measurement 82 tons, H.P. of engines 25 (nominal), draft of water 3 ft., geared engines, brass propellers, Penn's patent *lignum vitæ* screw shaft bearings. The engines are being constructed by Messrs. Summers and Day, Northam Iron Works.

The Anglo-French Steam Packet Company have established a line of steamers between St. Petersburgh and Great Grimsby, in connection with the Manchester, Sheffield, and Lincolnshire Railway.

HARBOURS, DOCKS, CANALS, &c.

The New Britannia Pier at Great Yarmouth is expected to be formally opened in June.

The Norfolk Estuary Works are being actively proceeded with.

Navigation of the Tyne.—Immediate measures are to be taken for its improvement by the removal of several shoals and obstructions by means of dredging.

The Northumberland Dock has been lighted with gas.

Greenses Harbour.—The Duke of Northumberland lately directed Messrs. Brooks and Taylor, civil engineers, to examine and report on the best mode of enlarging and improving this harbour.

Grimsby.—The new graving dock is of the following dimensions : Length from gates to head, 400 ft. ; length on blocks, 350 ft. ; average depth of water on sill, 19 ft. 6 in. ; average depth of water at the highest spring tides, 22 ft.

Harbours of Refuge in the Bristol Channel.—It is stated that £200,000 will be supplied by the Government for division between the four ports of Padstow, St. Ives, Clovelly, and Mumbles.

Chatham Dockyard.—In order to expedite the vessels and works in progress, additional artizans have been taken on.

A Lighthouse is to be erected on the Hanois, a group of rocks to the south-west point of Guernsey.

Dublin.—Two timber wharfs are to be constructed at North Wall Quay. Mr. George Halpin, civil engineer.

Londonderry.—A new graving dock is to be built here.

Cherbourg.—The inner dock is 1,260 ft. long and 600 ft. broad. It is capable of receiving an entire fleet, which will be quite safe from an enemy's fire at the greatest distance at which it has ever been known. The execution of this dock cost enormous trouble, being cut out of the solid rock to a depth of 54 ft. The excavation of the dock was effected by a new description of mine, which explodes, not loudly, but with a dead noise, and it raises the soil to the extent of some 100 yards. This dock, which is completely isolated, will communicate with the other docks by a sluice 1,200 ft. long, and by another 300 ft. long.

London Docks.—The extensive works here have been completed. They comprise an entrance-lock from the Thames, a basin which, combined with the old Shadwell basin, will give a water area of above six acres, and a lock communicating with the Company's present eastern dock. The locks are each 350 ft. long between the outer and inner gates, divided by a centre pair of gates into two locks, 200 and 150 ft. long respectively. They are 60 ft. wide, and will have 28 ft. of water on the sills at Trinity high-water datum.

Harbours of Refuge, Dover.—The vote required for the financial year 1858-9, is £34,000 ; subsequently £270,000 will be required. For Alderney, £60,000 ; hereafter £578,000. For Portland, £76,000 ; hereafter £119,125. At Jersey the works are at present suspended, but £395,000 will be asked hereafter.

The Mersey Dock Board have accepted the tender of Messrs. Pickup and Buchanan for the construction of a 50 H.P. high-pressure engine, for £1,256 10s. It is said that Messrs. Nasmyth, of Patricroft, are to supply a steam-piling engine.

Kiama Harbour.—Kiama is about 60 miles to the south of Port Jackson, in the centre of the Illewarra district, the garden of New South Wales. Surveyors are now engaged making a survey of the harbour for the purpose of improving it.

BRIDGES.

The entire outlay on Chelsea New Bridge has been £85,319.

Stockport.—The Vernon Bridge over the Mersey, connecting Stockport with Heaton Lane, is nearly completed.

The Bridges over the Boyne.—Sir John Macneill has been appointed Engineer-in-Chief for the two new bridges. The plans of Mr. Bower, C.E., stated by us in our last Number (page 126) to have met with the approbation of Mr. Gibbons, C.E., have been submitted to him. He said—we quote the "Drogheda Argus"—" No better plans could be given, but they were too expensive. He would give them plans of cheaper bridges, and on pier would be in the centre of the river. He said the bridges he would plan would cost in their iron work but one-half the estimated cost of £10,000. He would give a draft to Mr. Bower, and tell him what to do."

County Westmeath.—Newpass Bridge over the Black River is to be rebuilt.

BOILER EXPLOSIONS.

Explosion of a Boiler at Lincoln.—The explosion has before been alluded to at p. 126. The boiler-house (in which are fixed three boilers of large dimensions, the one in which the explosion occurred being in the centre) faces the Great Northern Railway, from which a tramway leads to a drop, whence coals are shot in front of the furnaces. Between this drop and the mill-yard is a gate or trap-door, and within this a coal waggon was standing on the rails. The force of the explosion must have been terrific. The coal and slack lying in front of the boilers were blown at the trap-door, which fell like pasteboard, and was found covered with coal and rubbish to the depth of 3 or 4 in. ; and the Brayford Island, which must be distant at least 600 yards, was covered with grime. Several portions of the shattered fire-box bars were driven completely across the railway, and a piece of iron weighing 2 lbs. was hurled a considerable distance. The railway waggon in front of the boiler bears numerous marks, showing that it must have offered considerable resistance to the force of the steam. The floor above the boiler-house was also blown to pieces. At the moment the explosion occurred, Mr. Tate, engineer, and Upton, a bricklayer's labourer, were standing on this floor, which had been undergoing some repair. On hearing the boiler explode, Mr. Tate made for a ladder leading to another room, but he missed the hand rope, and fell on his hands and feet into the boiling water, which was pouring from the flue to the floor, while the place was filled with steam. Salt, the assistant engineer, was somewhere in front of the boiler, and was overtaken by the full force of the steam, in attempting to escape by a side door. Passing across, and connected with the three boilers, is the feed-pipe. This was snapped asunder in consequence of the violence of the explosion causing the boiler, ponderous as it is, to start from the massive masonry in which it was set. The boiler, which was considered to be well constructed, has just undergone repair, and had only been at work nine hours when the explosion occurred. The exterior presents little appearance of damage.

A Fearful Boiler Explosion has occurred at the pit belonging to Messrs. Charlesworth, between Dodworth and Stainborough, and about 3½ miles from Barnsley. The boiler itself, which weighed nearly 5 tons, by the great force of the explosion, was sent upwards with great velocity, and having cleared in its rapid flight the engine-house, between 30 ft. and 40 ft. high, it struck two corners of the chimney towards the top, and then landed about 30 yards on the other side of it, on the edge of the pond. It appeared as if it had been crumpled up like so much paper, some portions of it being torn asunder, whilst some of the iron, an inch thick, was snapped in two. Another boiler, to which the burst one was attached, was also considerably damaged and displaced, the valves and connecting pipes being destroyed. At the time of the explosion the fireman was fortunately on the pit hill, and there were ten or twelve persons and eight horses in the pit ; these were all pulled out by means of horses (the machinery of course being entirely deranged), which occupied some time. The engine-house escaped with little damage, but the chimney, having been struck in several places, and rather shaky, will in all probability have to be taken down and rebuilt.

Tottington, May 2.—A boiler exploded here at the mills of Messrs. James Holt and Co., cotton manufacturers. It is reported that the boiler has been long in use, and that the plates were thin, and insufficient to bear the pressure.

APPLIED CHEMISTRY, &c.

M. Persoz, Professor of Chemistry at the Conservatoire des Arts et Métiers of Paris, has just published a most interesting discovery of his, by which photography may be applied to the ornamenting of silk stuffs. The bichromate of potash is a substance commonly used in photography, being extremely sensitive to light. If a piece of silk stuff, impregnated with this salt, be exposed to the rays of light penetrating through the fissures of the window-blinds in a closed room, the points where the stuff has received these rays of light will assume a peculiar reddish tint. Now, suppose a piece of metal or of strong paper to be cut out after a given pattern, and to be laid upon a piece of silk prepared as before ; if exposed to the sun, or, better still, to simple daylight, the pattern will be reproduced in a few instants. The pale red which the parts acted upon by the light assume is so permanent that nothing can destroy it ; nay, it will fix other colours, such as madder, campeachy, &c., just like a mordant, and, in that case, it will modify the colour of those substances in absorbing it. The experiment may be varied as follows :—Let a fern leaf be laid upon a piece of prepared silk, and kept flat upon it by a pane of glass ; then that part of the silk which is protected by the leaf will retain its original colour, while all the rest will receive the impression of light, as above described, forming the ground on which the figure of the leaf will appear in white, grey, or whatever other colour the silk may have had before the operation. The richest patterns may thus be obtained on plain silks, and at a comparatively small expense.

NOTICES TO CORRESPONDENTS.

Our Correspondents will receive replies to their several inquiries per post.

We are compelled to postpone several Reviews and Notices of Books until the appearance of our next Number.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 21st December, 1857.

3126. J. H. Nosworthy, London—Apparatus for exhibiting cards, bills, and other like advertisements.

Dated 6th February, 1858.

220. L. F. Candelot, 16, Rue St. Quentin, Paris—Divers anti-nitrous cements applicable to rendering damp surfaces impervious.

Dated 9th February, 1858.

241. G. Pringle, Prestonpans, N.B.—Machinery or apparatus for propelling ships or vessels.

Dated 16th February, 1858.

298. J. Coutts, Willington-lodge, Willington, Newcastle-on-Tyne—Improved paint, pigment, or composition, more particularly adapted for coating the hulls of ships, either iron or wooden, so as to prevent damp, corrosion, or fouling.

Dated 8th March, 1858.

466. B. B. Stoney, Dublin—Buoys, floating beacons, and other similar floating bodies.

Dated 9th March, 1858.

476. H. Deacon, Widnes, Lancashire—Purifying alkaline lees.

Dated 10th March, 1858.

486. J. F. Gee, Wrexham—Joining of earthenware pipes for drains, sewers, and telegram wire conductors, also suitable for the conveyance of liquids, gas, and steam under pressure, when jointed.

Dated 11th March, 1858.

495. F. E. D. Hast, Aldermanbury — Manufacturing stearine.

Dated 17th March, 1858.

542. W. S. Clark, Atlas Works, Upper Park-place, Dorset-square—Metallic canisters for holding gunpowder and other articles.

Dated 23rd March, 1858.

608. E. Peters, Grimsby—Burning bricks and other articles made of brick earth and clay.

Dated 24th March, 1858.

617. C. Kottula, Liverpool—Purifying soda leys, whereby they are rendered capable of saponifying all fatty matters or resins.
618. C. Kottula, Liverpool—Compact neutral soap.
624. A. L. Thirion, Aische-en-Refail, Belgium—Method of transforming circular movements.

Dated 26th March, 1858.

644. J. J. T. Schlœsing, 22, Rue d'Austerlitz, and E. Rolland, 21, Rue de Bellechasse, Paris—Manufacture of carbonates of soda.

Dated 27th March, 1858.

656. F. Bousfield, 20, Hereford-terrace, De Beauvoir-road, Kingsland—Production of duplicate writings.

Dated 3rd April, 1858.

704. A. Pelez, 9A, Mortimer-street, Cavendish-square—A new apparatus for deepening rivers and rendering them navigable.
714. E. Edwards, Birmingham—Glass finger plates for doors and other articles of like manufacture.

Dated 5th April, 1858.

720. W. S. Clark, Atlas works, Upper Park-place, Dorset-square—Grain and grass harvesting machines, and in the automatic delivery thereof of cut grain.
722. J. Smith, Oldham—Pile fabrics.
724. S. Fox, Stockbridge Works, Deepcar, and J. Chesterman, Sheffield—Stays or corsets, and in the manufacture of steel employed therein.

Dated 6th April, 1858.

726. L. T. Van Elven, Clapham-road—Apparatuses for raising and lowering weights.
728. H. Wetherell and G. Gray, Upper Chapman-street—An apparatus for preventing down draughts and currents in chimneys, flues, and shafts.
730. J. Camp, John-street, Tysoe-street, Clerkenwell—Expanding portfolio.
732. C. H. Chadburn, Liverpool—Pressure gauges.
734. J. Erckmann, Rue Faubourg, St. Honoré, Paris—Galvanic batteries.
736. B. Blanché, Bordeaux, France—Using Malacca and Manilla cane instead of whalebone.
738. J. Rose, Glasgow — Applying heat, cold, moisture, fumes, vapours, and other agents, in medicine and surgery.

Dated 7th April, 1858.

740. E. P. Sibille, 11, Conduit-st., Regent-st.—Apparatus for warming or cooling atmospheric air, water, and all liquids of a similar density to it, warming them to the degree of heat necessary for their transformation into steam.
741. A. Casartelli and L. Casartelli, Liverpool—Pressure and vacuum gauges.
742. F. Haines, Lime-street—Application of india-rubber as a substitute for whalebone and steel ribs.
743. W. A. Gilbee, 4, South-street, Finsbury—Machine for corking bottles.
744. J. Wright, 10, Alfred-place, Newington-causeway, Southwark—Treating leather in order to render it waterproof.
745. W. Armitage, Farnly Iron Works, and H. Lea, Farnly, near Leeds—Manufacture of iron.
746. R. Worthy, Albert-street, Regent's-park—Medical fomentations.
747. G. W. Baker, Park Farm, Woburn — Signal apparatus.
748. W. Nimmo, Manchester—Printed woven fabrics.
750. John Doherty, Edinburgh—Buttons or dress fastenings.
751. C. F. Whitworth, Sheffield—Signal apparatus for railways.

Dated 8th April, 1858.

754. J. Cartwright, Shrewsbury—Apparatus for transmitting motive power for driving machinery.
755. G. Davies, 1, Serle-street, Lincoln's-inn—Manufacture of wads for ordnance.
756. G. E. Taylor, Oatlands, Leeds—Machinery for raising the pile of cloths.
757. G. Rowland, Brussels—Artificial whalebone.
758. F. W. Mowbray, Bradford, and J. Broadley, Saltaire,—Apparatus employed in weaving.
759. W. Clark, 63, Chancery-lane—A burner for candles.
760. T. Greenwood, J. Batley, and J. Dockray, Leeds—Machinery for carding, opening, straightening, and preparing to be spun, tow and other fibrous materials.
761. T. Roberts and J. Dale, Manchester—Production of a substitute for oil used with pigments.

Dated 9th April, 1858.

762. T. Greenwood and J. Batley, Leeds—Machinery for heckling flax and other fibrous materials.
763. W. Ager, Rohrsburg, U.S.—Rice cleaning machinery.
764. K. McCafferty, Lancaster, U.S.—Preventing incrustation in steam boilers.
765. W. R. Jackson, Baltimore, U.S.—A self-acting railway break.
766. G. Smith, 21, Wichampton-st.—Manufacture of close stools, night commodes, and water-closets.
767. H. Bayley and J. Greaves, Staleybridge—Improvement applicable to certain machines for spinning and doubling fibrous substances.
769. Hon. W. Talbot, Army and Navy Club, Pall-mall—Apparatus to facilitate the lowering and detaching of boats from ships or vessels.
770. H. Bauerrichter and C. G. Gottgetreu, Charterhouse-sq.—Printing gold, silver, bronze, and other metal, on glass.

Dated 10th April, 1858.

771. R. M. Ordish, 18, Great George-street, Westminster—Suspension bridges and suspended girder bridges.
772. A. Lees, Soho Iron Works, Oldham, and D. Schofield, Oldham—Construction of carriages for certain machines used in spinning and doubling.
773. G. Guyot, Denain, France—Welding broken cast-iron pieces.
774. A. Neumann, London—Strop for sharpening razors, knives, and other edged instruments.
775. P. Brun, 1, Rue de Grenelle, St. Honoré, Paris—Improved blowing fan to steady or portable forges, with or without reverberatory furnaces, as well as to ventilation in general.
777. S. T. Parmelee, Edinburgh—Belting for machinery.
778. F. A. Lecornu, Paris—Drawing and levelling instruments.
779. W. G. Armstrong, Newcastle-upon-Tyne — Firing or igniting explosive projectiles.
780. J. Pouncy, High West-st., Dorchester — Production of photographic pictures.
781. D. McCrae, Greenock—Preserving ships' bottoms and other exposed surfaces from fouling and injury or decay.
782. W. Rowett, Netherfield-road, Liverpool—Construction of electric telegraph cables or ropes.
783. A. Manbré, 10, Rathbone-place, Oxford-street—The manufacture of a colouring matter, for colouring spirits and other liquids from the sugar of potatoes.
784. J. Rae, Blackwall—Iron ships.
785. A. C. Thibault, Paris—Paperhangings.

Dated 12th April, 1858.

786. J. Bailey, E. Oldfield, and S. Oddy, Salford—Machinery for driving grindstones and glazers.
787. S. Bickerton, Oldham—A thermo-pneumatic lubricator for oiling shafts, axles, machinery, &c.
788. P. Michel, Paris—Neckcloth or tie, means of connecting ties to collars, and an improved collar.
789. T. Kay, Oxenhope, near Keighley, Yorkshire—Method of producing or obtaining heat suitable for the singeing of yarns, and textile fabrics, which heat is also applicable to other heating purposes.
790. W. Clark, 53, Chancery-lane—Pattern surfaces or cards of Jacquard apparatus.
791. P. Ratel, Paris—Machine for depositing grain and manure.

Dated 13th April, 1858.

792. H. Whittles, Rochdale, J. Schofield, and E. Leach, Littleborough, and J. Lord, Rochdale — Steam engines.
793. T. Spiller, 5, Red Lion-sq.—Exhibiting slides in the stereoscope, and preserving them from injury, to enable each slide to be conveyed to the point of view, and then after use deposit them each in its place in the box, without handling or exposing the slides to the chance of being soiled, keeping them always under cover in safety.
795. T. T. Jopling, Dunning-st., Bishopwearmouth—Water closets.
796. R. A. Brooman, 166, Fleet-street—Cranes or apparatuses for raising and lowering weights.
797. P. Schafer and F. Schafer, Brewer-st. — Fastenings for travelling bags, portmanteaus, and other like articles.
798. P. A. Yardin, Moorgate-street—Trusses.
799. T. B. Aysbford, 1, Britannia-road, Walbam-green, Fulham—Omnibuses.
800. W. E. Newton, 66, Chancery-lane—Operating railway brakes.

Dated 14th April, 1858.

801. R. Armstrong, North Woolwich, and J. Galloway, Manchester—Apparatus and furnaces for heating, welding, or melting metals, parts of which are applicable to other furnaces.
802. G. Pye, Blackburn, R. Smith, Longridge, near Preston, and B. Croasdale, Whitton, near Blackburn — Looms.
803. W. C. Holmes and W. Hollingshead, Huddersfield—Metal castings.
805. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris — Voltaic batteries.
806. J. Gorham, Tunbridge, Kent—Optical instruments.
807. T. Osborne and R. A. Bell, Derby—An apparatus for suddenly detaching railway carriages or waggons.
808. J. Gray, Uddingston, Lanark, N.B.—Ploughs.
809. C. Mather, Salford Iron Works, Salford, and H. Charlton, Blackfriars-st., Manchester — Drying cotton, linen, wool, yarn, seed and other articles.
810. E. Green, Wakefield—Implements for harrowing, pulverizing, cleaning, and breaking up land.
811. J. H. Johnson, 47, Lincoln's-inn-fields—Sawing machines.
812. J. Knight, Woodhouse Mills, near Rochdale—Machinery for scouring, washing, and cleansing textile fabrics.
813. A. F. Newton, 66, Chancery-lane—Rotary pumps.

Dated 15th April, 1858.

814. C. Davies, Duffryn, W. Jones, Caerleon, and J. Jones, Maindee, near Newport—Method of finishing tinned, terne, or lead plates, without the use of grease.
815. F. Preston and W. McGregor, Manchester—Machinery for forging and cutting files.
816. F. S. Thomas, Junction-street, Kentish-town — Propelling carriages upon railways.
817. L. Cowell, Adelphi — An instrument or nippers for cutting the wired, corded, or like fastenings of corked bottles.
818. J. Meyers, Westmoreland-place, City-road—Treatment of dark fur skins.
819. W. Spence, 50, Chancery-lane—Pedestals and journal boxes of railway carriages.
820. W. E. Newton, 66, Chancery-lane—Boots and shoes.
821. J. Harris, Woodside, and T. Summerson, Haughton-le-Skerne, near Darlington—Railway chairs.
822. A. H. A. Durant, Conservative Club, St. James's—Apparatus for husking and winnowing castor (and other) seeds and berries.

Dated 16th April, 1858.

823. J. Boot, Manchester—Apparatus for making labels.
824. J. G. Hodges, Manchester—Machinery for embroidering.
825. P. Brotherhood, Chippenham—Locomotive and steam boilers.
826. G. G. Brown, 25, Wickham-terrace, New-cross, Deptford—Ships' binnacles.
827. G. Walker, Edgbaston, Warwickshire—Union apparatus for cleaning and polishing knives and forks and boots and shoes, and which said apparatus is also applicable for sharpening knives and sharpening or cleaning other articles.
828. A. P. Price, Margate—Treatment of certain zinc ores and compounds of zinc, and manufacture of zinc and oxide of zinc.
829. A. P. Price, Margate—Obtaining cadmium, and certain compounds thereof.
830. A. P. Price, Margate—Treatment and smelting of certain argentiferous or silver ores.
831. J. H. Johnson, 47, Lincoln's-inn-fields — Preparing printing surfaces.

Dated 17th April, 1858.

832. J. Luis, 1B, Welbeck-street, Cavendish-square—Window frames for railway carriages.
833. E. F. Sans, Epernay (Marne), France — Apparatus serving to measure upon a large scale the smallest pressions of any fluid matters.
835. A. A. Lutereau, Paris — Machinery to polish wholly or partly leather paper-hanging, and all other febril stuff, that is to say, that a piece can be polished in several parts, having spaces unpolished.
836. F. C. Gilbert, Paris (Petite Villette), Rue du Depotoir, 44 (Seine), France—Composition to purify water-closets.
837. D. Chalmers and J. T. Swallow, Manchester—Looms.
838. G. W. Bancroft, Bow-road—Construction of certain parts of railway carriages, to insure safety in travelling.
839. J. R. Chirm, jun., Birmingham—Chimney pot or top.
840. W. Carron, Birmingham—Moulds for casting nails, spikes, and bolts.
844. C. Hawker, Fishbourne, Isle of Wight—Cartridge for fire-arms.
845. J. H. Johnson, 47, Lincoln's-inn-fields—Sewing machines.
846. T. Luck, Spalding-common, Lincolnshire—Machinery for raking and seeding land.
847. W. Latham, Russell-court, Drury-lane—Manufacture of hats and caps.
848. J. G. Jennings, Holland street, Blackfriars—Construction of sewers, culverts, arches, and other similar

structures, and the manufacture of blocks of clay and pottery.

Dated 19th April, 1858.

849. M. B. Westhead and H. Baines, Manchester—Machinery or apparatus for the prevention of accidents, applicable to hoisting and other lifting machines employed in connection with railways or other places where heavy bodies require to be moved from one level to another.
850. J. Drake, jun., Huddersfield—Sewing machines.
851. W. H. Ridgway, East View-place, Hanley, Staffordshire—Opening the covers of jugs.
852. W. Bullough and J. Harrison, Blackburn—Looms for weaving, and machinery for winding the corn used in the manufacture of weavers' healds.
853. J. Howorth, Farnworth—Apparatus to facilitate the discharge of smoke and prevent its return, which said apparatus is also applicable for the ventilation of buildings.
854. H. Edwards, Dalston—Trowsers.
855. M. Henry, 77, Fleet-st.—Manufacture of candles, and preparing materials for the same, and apparatus employed therein.
856. J. M. Rowan, Glasgow, and T. R. Horton, Birmingham—Steam engines and boilers.
857. E. K. Calver, Sunderland—Formation of harbours of refuge.
858. J. Armstrong, 15, Nelson-street, Sunderland—Apparatus used for preserving timber.
859. W. Clark, 53, Chancery-lane—A new instrument for taking the altitude of the sun, to be termed the "Helypsometer."

Dated 20th April, 1858.

861. J. Whiteley, Stapleford, Nottinghamshire—Machinery for the manufacture of looped fabrics.
862. W. S. Clark, Atlas Works, Upper Park-place, Dorset-square—A nautical safe and life preserver.
863. W. S. Clark, Atlas Works, Upper Park-place, Dorset-square—Cultivator tooth for agricultural purposes.
864. R. Peacock, New Holland, Lincolnshire—Apparatus for preventing smoke in furnaces, and in effecting a more perfect combustion of fuel.
865. G. Finlayson, Gighty Burn, N.B.—Apparatus for sowing or depositing seeds in land.
866. J. B. Smith, Hockley, near Birmingham—Adjusting the position of pendant and other lamps.
867. D. Moore, Brooklyn, U.S.—Fire tongs.
868. J. Leadbetter and G. Terry, Leeds—Manufacture of metallic trunks.
869. J. Rawstorne, Abingdon-villas, Kensington—Means for stopping or retarding the progress of ships or vessels.

Dated 21st April, 1858.

870. J. Adkins, Church-street, Islington, and T. O. L. Buss, Hatton-garden—Ships' compasses.
871. A. Ogilvie, Denmark-street, Soho-square, and J. Richardson, 449, New Oxford-street—Apparatus for working steam engines.
872. A. Shrimpton, 112, Stanley-street, Pimlico—Manufacture of metallic bedsteads, and articles for sitting, lying, or reclining upon.
873. M. Ross, Gallowtreegate, Leicester—Manufacture of frames for looking-glasses, pictures, and other representations.
874. J. Copcutt, 50, St. John-street, Clerkenwell—Manufacture of gas.
875. W. H. F. Talbot, Lacock Abbey, Wiltshire—Engraving.
876. J. Horsey, Greek-street—India-rubber pouches, and elastic bands or ring fastenings for pouches.
877. E. Green and E. Green, jun., Wakefield—Apparatuses for generating and superheating steam, and for heating.
878. J. J. Lane, Newgate-street—Arrangement of punches and dies in eyelet machines.
879. B. Parker, Clapham—Permanent way of railways.

Dated 22nd April, 1858.

881. T. Hutchison, Paisley—Shawls.
882. S. Clegg, Dover-cottage, Putney—Gas meters.
884. G. Gilmour, Massachusetts, U.S.—Telegraph cable or rope shackle.
885. G. Smith, Morriston, near Swansea, Glamorganshire—Manufacture of zinc.
887. P. Maugey, Paris—Diaphragms for optical instruments.
888. H. A. de Saegher, Brussels—A composition proper to prevent the incrustation of steam boilers.
889. W. Beck, New York.—Machinery for weaving fringes and other fabrics.
891. T. Harrington, Dover—Mode of ventilating the hold and other parts of ships.
892. J. B. Paddon, Gray's-inn-road—Gas regulators.
893. J. Stocks, Berry Brow, and Charles Cave, Lockwood, Yorkshire—Apparatuses for coupling and uncoupling waggons and carriages on railways.
894. T. Donkin, Bermondsey—Apparatus employed in the manufacture of paper.

Dated 23rd April, 1858.

895. T. Greenshields, 11, Little Titchfield-street—Purifying gas produced from coal, and obtaining ammoniacal and other alkaline salts.
897. C. Atkinson, Sheffield—Venetian blinds.
898. H. J. Sillem, Liverpool—Machinery for the manufacture of sugar.
99. J. P. Pirsson, New York, U.S.—Condensers of steam engines.
900. W. Foster, Black Dyke Mills, near Bradford—Multitubular and other boilers for the prevention of smoke and economising fuel.
901. A. Jenkin, Carrick Mines, Dublin—Furnaces for the reduction and calcination of lead, tin, and copper ores.
902. J. O. York, Paris—Obtaining power when bi-sulphuret of carbon is used,
903. C. Lungley, Deptford Green Dockyard—Construction of portable ships and boats and their appurtenances.

Dated 24th April, 1858.

905. J. Maitre, Thieffrain (Aube), France—Apparatus for washing iron mineral.
907. R. Bodmer, 2, Thavies-inn, Holborn—An improved apparatus for removing sand and similar loose material from docks, rivers, and waterways.
908. F. Lillywhite and J. Wisden, Coventry-st.—Apparatus for projecting cricket balls, or other similar articles.
909. W. A. Clark, Bethany, U.S.—Expansive bits.
910. J. Horton, Ashburton—Construction of horse-hoe.
911. J. Lawson, Leeds—Machinery used in spinning flax and other fibrous substances.

Dated 26th April, 1858.

912. L. Newton, Oldham—Cop tubes used in spinning machinery.
913. B. Burleigh and F. L. Danchell, Great George-street, Westminster—Filters.
914. J. M. Fisher, Taunton—Chimney tops or cowls.
915. J. Braidwood, Glasgow—Steam boilers and furnaces.
916. J. Westerby, Huddersfield—Apparatus for lubricating pistons.
917. W. Jones, Pendleton, Lancashire—Machinery for ringing bells.
920. J. Seaman, Britannia Iron Works, Bedford—Apparatus for effecting the working or cultivation of land, and the means of driving the same.
921. W. Foster, Lower Tower-st., Birmingham—Vent-tap.
922. E. E. Lee, Birmingham—Modes of applying vitrifiable materials for the ornamentation of metal, buttons, clasps, and other articles of dress.
923. T. Dobson, Birmingham—Apparatus for forging iron.
924. W. E. Newton, 66, Chancery-lane—Covering roofs and other parts of buildings with slate or other materials.

Dated 27th April, 1858.

925. E. Hunt and H. D. Pochin, Salford—Treatment and application of resins and resinous substances.
926. E. White, Bath—Facilitating reference by means of indexes.
927. E. Simons, Birmingham—Cornices and cornice poles for window and other curtains.
928. C. F. Vasserot, 45, Essex-st., Strand—Construction of blast-engines, pneumatic machines, and pumping engines generally.
929. J. Fraser, Blue Vale Chemical Works, Gallowgate, Glasgow—Manufacture of nitrate of potass.
931. G. R. Tovell, Mistley, Essex.—Construction of ships and other vessels.
933. M. Moss, 15, Marlborough-place, Old Kent-road—Ladies' petticoats.
934. J. Hulett, Aldersgate-street—Shirt collars.
935. M. Sautter, Paris—Diving bells.
936. W. Keiller, Dundee, N.B.—Cutting, reducing, or dividing vegetable, animal, and other substances.
937. W. E. Newton, 66, Chancery-lane—Machinery for splitting leather or skins.
939. J. F. M. Charpentier, 39, Southampton-row, Russell-square—A fire escape.

Dated 28th April, 1858.

940. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Apparatus for the condensation of smoke.
941. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Saponaceous compound.
942. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Process for combining silk with other textile substances.
943. B. Martin and C. J. Light, Great George-st., Westminster—Railway turntables.
944. E. Tomlinson, Manchester—Cop tubes, and in the machinery or apparatus to manufacture the same.
945. C. F. Vasserot, 45, Essex-st., Strand — Waterproof fabrics.
946. W. Clark, 53, Chancery-lane—Railway crossings.
947. A. V. Newton, 66, Chancery-lane—Construction of paddle-wheels.
949. A. Winkler, Vienna—Printing or producing impressions in gold, silver, and oil colours upon metallic plates, and in the mechanism employed therein.
950. J. H. Johnson, 47, Lincoln's-inn-fields—Furnaces for the melting and reduction of steel, copper, zinc, and other metals.

Dated 29th April, 1858.

951. J. Martin, Barmer, near Fakenham, Norfolk.—Apparatus for reducing, cutting, or pulping roots.
952. S. Bartlett, 135, Lupus-st., Pimlico—Machinery for forming gutta percha soles, and uniting them to the upper leathers of boots or shoes.
953. E. Simons, Birmingham—Ordnance.
954. A. M. Perkins, Francis-st., Gray's-inn-road — High pressure steam engines.
955. C. Lawrence, Honley, near Huddersfield — Steam engines.
956. R. Johanny, Vienna—Construction of furnaces.
957. W. Smith, 18, Salisbury-st., Adelphi—Spinning machinery
959. D. Auld, Glasgow—Working furnaces and steam boilers.

Dated 30th April, 1858.

960. R. B. Huygens de Lowendal, 89, Chancery-lane—Construction of springs, and for their new application to the working of machinery
961. J. Chadwick, Manchester, A. Elliott, West Houghton, Lancaster, and W. Robertson, Manchester—Machines for twisting and winding silk direct from the cocoons, such machines being of the class commonly known as throstles.
962. J. Luis, 1B, Welbeck-st., Cavendish-sq. — Apparatus for separating two substances of different densities; among others may be mentioned pit coal, from the slate which it contains.
963. B. E. Guyot de Brun, Pantin, Rue de Montreuil, 18, Seine, France—Leather tissue and other tissues rendered waterproof by a new process.
965. E. T. Hughes, 123, Chancery-lane—Regulator and float combined, applicable to the manufacture of paper.
966. J. C. Fnucon, Paris—Bedsteads, bed bottoms, seats, and articles for lying and reclining on.
967. J. Chapman, jun., North Foreland Lighthouse—Producing a substance entitled felted woody-fibre, convertible into useful articles, and applicable to the internal fittings and decorations of dwelling-houses.
968. G. H. Ellis, New Malton, Yorkshire—Cleaning boots and shoes by machinery, and apparatus for the same.
969. W. Clark, 53, Chancery-lane—Obtaining motive power, and apparatus connected therewith.
970. P. A. Godefroy, 3 King's-mead cottages—Mode of separating vegetable from animal fibres or fabrics.
971. C. A. J. Demanet, 43, Rue de la Science, Brussels—The extraction of coals and minerals from mines.
972. J. H. Johnson, 47, Lincoln's-inn-fields—Suspension bridges.
973. A. Smith, Mauchline, Ayr, N.B.—Valves.

Dated 1st May, 1858.

975. R. Wardell, Stanwick, near Darlington—Reaping machines.
976. R. Illingworth, Blackburn—Safety-valves.
977. W. Spence, 50, Chancery-lane—Production and application of a material called French purple.
978. L. Talabot, 57, Rue de la Chassée d'Antin, Paris—Rolling railway and other bars.
979. W. Hopkinson and J. Dewhurst, Mayfield Print Works, Manchester—Apparatus for consuming smoke.
980. F. M. Gregory, Shavington, near Market Drayton—Chaff-cutting machines.

Dated 3rd May, 1858.

982. C. Schleicher, Bellevallée, Prussia—Machine intended to make the points of needles, pins, and all other similar articles.
984. E. S. Trower, Stansteadbury, near Ware, Herefordshire—Apparatus for treating flax, hemp, and other fibrous matters requiring like treatment.
986. J. G. Appold, Wilson-st., Finsbury-sq.—Apparatus for laying submarine telegraphic cables.

Dated 4th May, 1858.

988. J. Smethurst, Guide Bridge, Lancashire—Boilers for generating steam.
992. W. E. Newton, 66, Chancery-lane—Apparatus for mixing and moulding materials for the manufacture of fuel.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

841. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Medicinal compound for the treatment of epilepsy.—17th April, 1858.
842. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Portable tents for railway and other purposes.—17th April, 1858.
843. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Substitute for the pulverised cotton and wool employed in the manufacture of felted tissues, papers, and other fabrics.—17th April, 1858.
886. G. Gilmour, Massachusetts, U.S.—Improved messenger shackle block.—April 22, 1858.
919. A. F. Emery, Massachusetts, U.S.—Improved machine for sewing cloth and other material.—April 26, 1858.
930. J. H. Bennett, 8, Vamburgh-place, Leith—Arrangement of safety valves for steam, gas, or any aëriform or liquid body.—April 27, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4080. April 22. T. Parr, 55, Lower Union-street, Torquay—"Chimney Top."
4081. „ 24. J. Pierre and Co., 82, New Elvet, Durham—"Corset Fastener."
4082. „ 26. Burt and Potts, York-street, Westminster, S.W., "Wrought-iron Window and Frame."
4083. May 1. C. Weintraud, jun., Offenbach, "Porte Monnaie."
4084. „ 1. W. Spurrier, Birmingham, "Cover for Jug."
4085. „ 7. Fossick and Hackworth, Stockton on-Tees, "Cast Iron Waggon Wheel."
4086. „ 7. H. Lane, Wednesfield, near Wolverhampton, "Rabbit Trap."
4087. „ 8. J. Apperley and Co., Dudbridge Works, Stroudwater, Gloucestershire, "Roller Blind Spring."
4088. „ 18. L. Stead, 97, Norton-street, W., "Portable Combination Chair Stool, &c."
4089. „ 19. J. F. Meston, Mundford, Norfolk, "Fruit and Blossom Protector."

Early Appliances for expressing Oil

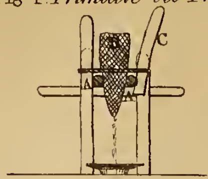


Fig 1. *Primitive Oil Press*

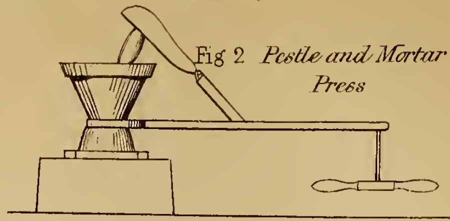


Fig 2. *Pestle and Mortar Press*

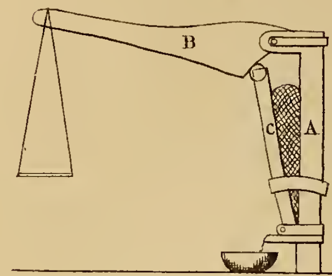


Fig. 3 *Single Lever Press*

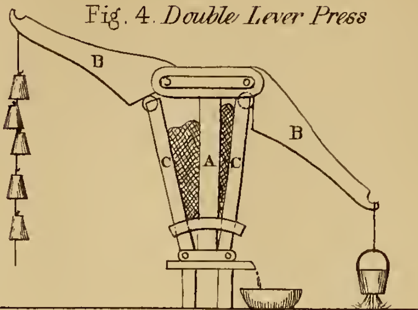


Fig. 4. *Double Lever Press*

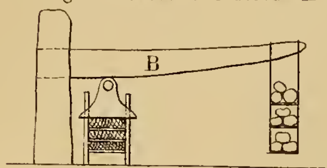


Fig. 5. *Horizontal Lever Press*

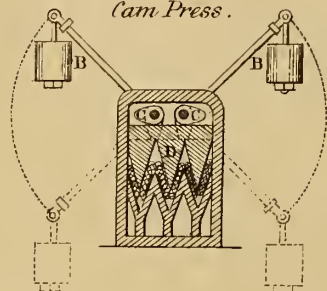


Fig. 6. *Lever and Cam Press.*

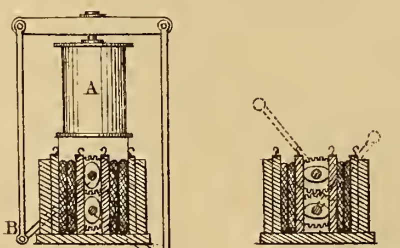


Fig 7 *Double Steam Cam Press.*

Scale 1/100th

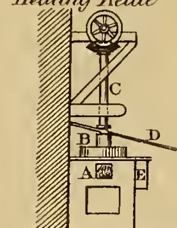


Fig 8. *Early Heating Kettle*

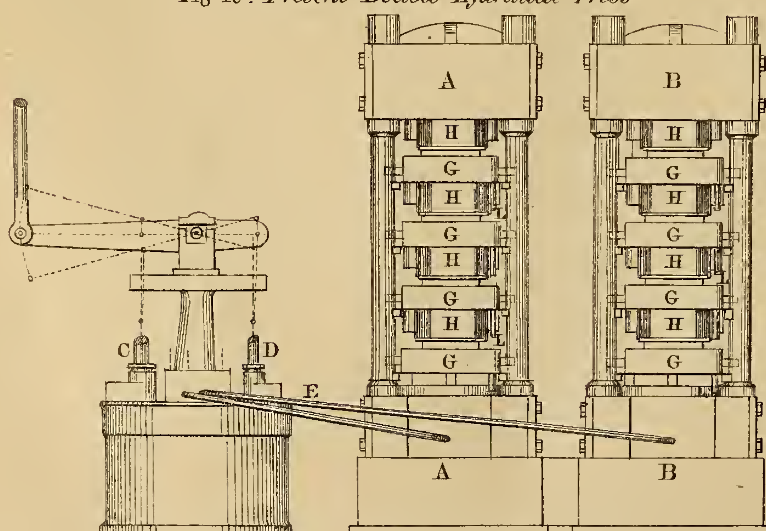


Fig 19. *Present Double Hydraulic Press*

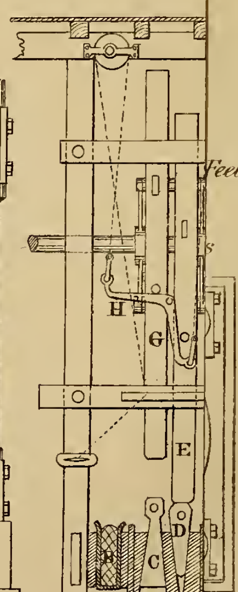


Fig.

Scale 1/30th

Modern Appliances for expressing

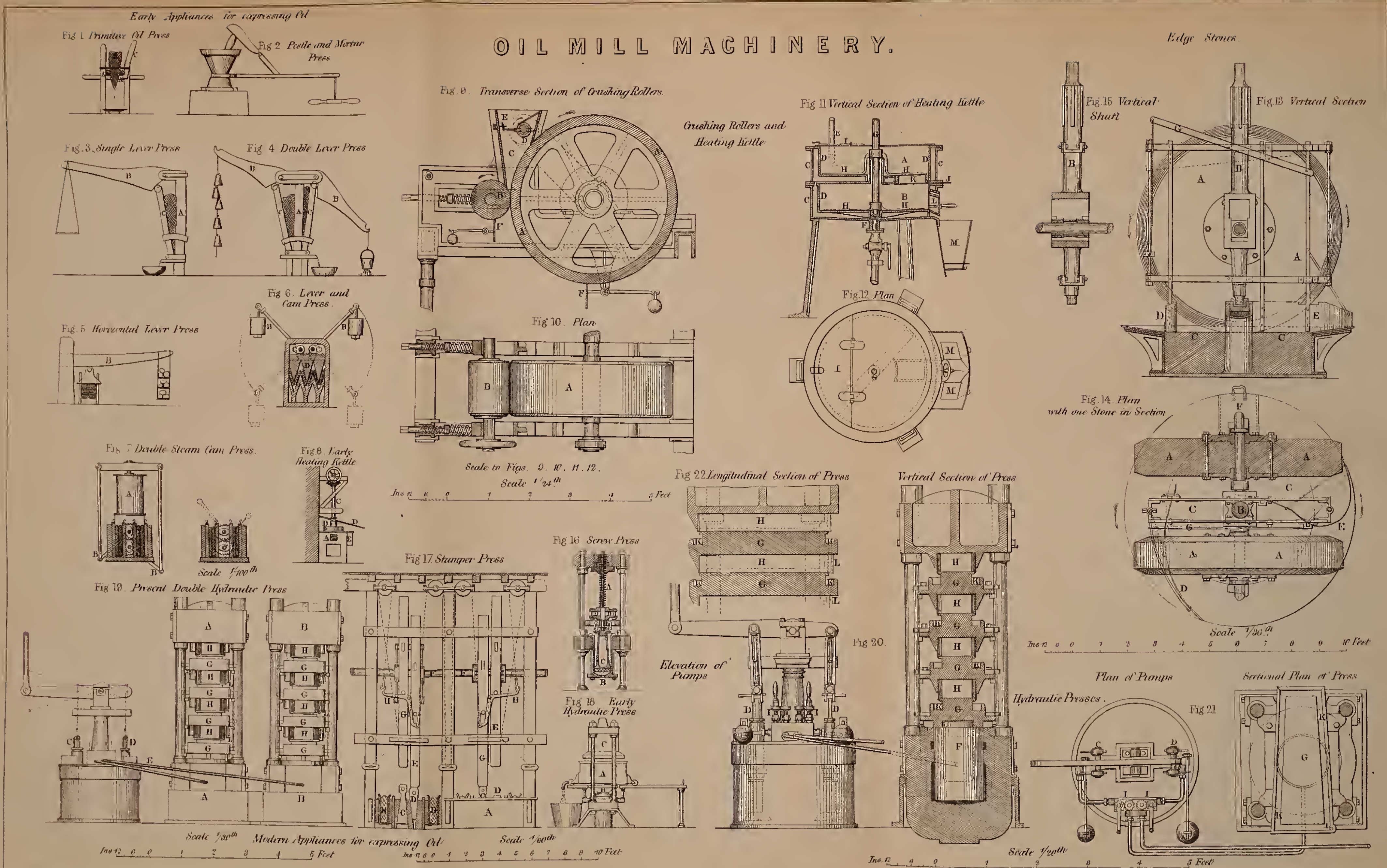
Ins 12 6 0 1 2 3 4 5 Feet

Ins 12

ion

Ins 12

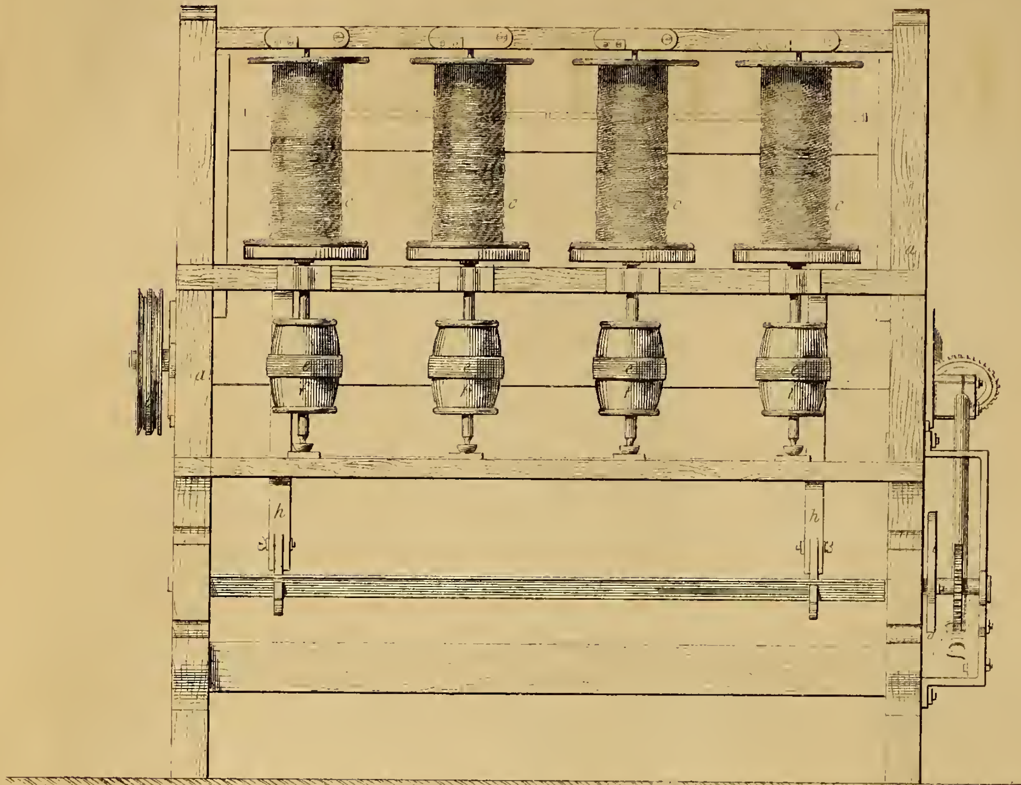
Feet



W. Smith C. E. direx

Winding Machinery.

Fig. 1. Front Elevation



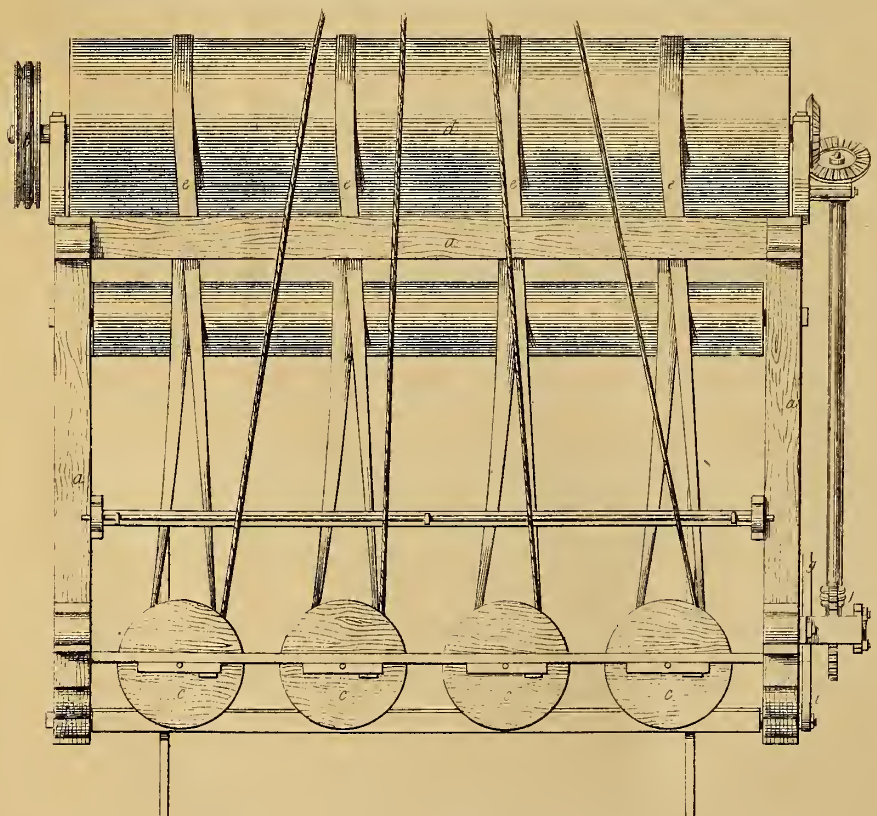
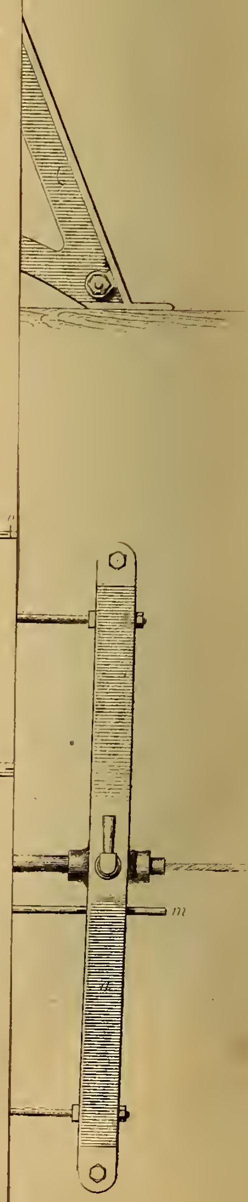


Fig. 2. Plan.



THE ARTIZAN.

No. CLXXXVI.—Vol. XVI.—JULY 1st, 1858.

HEMP AND FLAX SPINNING MACHINERY.

(Illustrated by Plate cxxvi.)

In The Artizan for 1857 will be found a series of Plates and descriptive matter, illustrating the processes of preparing and spinning hemp and flax more particularly suited for the manufacture of ropes, lines, &c. In The Artizan for February, 1858, will be found a short description of a second preparing machine, which description is illustrated by a large folded Plate, No. cxvii.

In The Artizan for April we gave another Plate (No. cxix.), exhibiting a view and details of the second preparing machine. Now the material, after it has been prepared in the machine last referred to, is delivered into cans in the form known as sliver, and in this state is removed to a machine called the compressor; this machine is shown in Plan, Fig. 1, and in elevation at Fig. 2 in the accompanying Plate (No. cxxvi.). The sliver, having been subjected to the operation of this machine, is then spun into threads or yarns in machines designed for the purpose, some of which machines we have already illustrated in The Artizan for 1857 and the present year. When the threads or yarns have been completed in the spinning machinery, they have to be wound on separate drums or bobbins, and which winding machinery is illustrated by Figs. 1, 2, and 3, in the same Plate (No. 126).

The sliver compressing apparatus, as shown in Plan, Fig. 1, and in Elevation, Fig. 2, consists of two triangular frames, *a*, *a*, held together by two extension bars or stretchers at the feet of the frames, whilst at the top or apex of the triangle a horizontal spindle working in bearings is shown, a rotatory motion being communicated to it by means of a flat band pulley or rigger. The can with the sliver which has to be compressed is placed by the side of the machine, and immediately under a small reel which rotates loosely on a pin projecting from the end of an overhanging arm; the sliver is carried over this reel, and into a trumpet-mouthed or conical tube, a vibratory motion being imparted by means of a short lever connected with a stud or crank-pin upon the face of a worm-wheel, *i*. Upon the horizontal shaft, and surrounding a considerable portion of its length, and occupying the greater part of the length between the triangular frames, *a*, *a*, is fitted a filling can, into which the sliver, when it has been compressed by passing through the conical tube, *f*, is received regularly coiled; this filling can is secured to the centre spindle, and revolves with it at a quick speed. On one end of this can (at the end next the trumpet or conical tube) is a cap or cover, *e*, and within the can, working on the square bar or centre spindle, is a solid piston or disc, which is held up in its place, or pressed against the end or against the inner surface of the cap, *e*; one end of this piston or disc being conical and made to correspond with the inner surface of the cap, *e*, it fits close against it when the machine is first put in action. The end of the sliver, after it has been drawn over the reel and through the conical tube, is passed through a slot or groove in the cap, *e*, and is then secured to the piston.

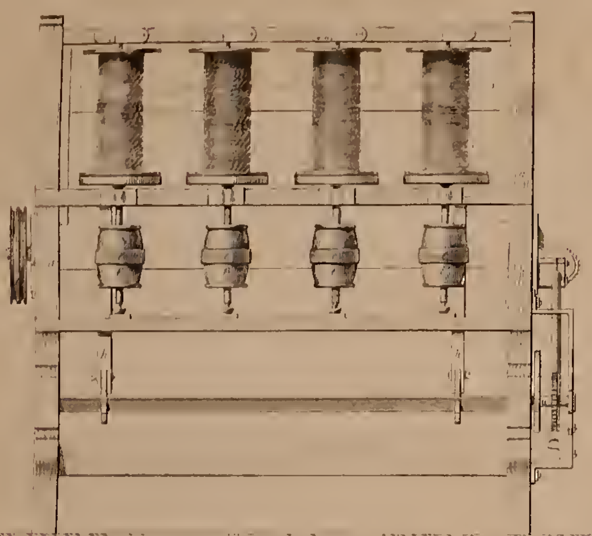
The horizontal spindle or shaft, *d*, together with the can, *b*, is caused to revolve at a suitably high speed, and the sliver is drawn into the can, *b*, and wound around the spindle or shaft, *d*, and is fed spirally in conical coils against the conical end of the piston, and is thus pressed firmly between it and the correspondingly conical inner surface of the cap or cover, *e*; the feeding-in is effected by the vibratory motion imparted to the small end of the conical or trumpet-mouthed tube, *f*, by means of the crank-pin or stud upon the worm-wheel, *i*, and the short rod or lever connected with the carriage upon which the conical or trumpet-mouthed tube is fixed. The process of winding the sliver continues, and the piston is pushed before it until the can is filled with the sliver thus compressed, when the piston, arriving at the spring, *l*, acts upon the rod, *m*, which throws the forked lever aside, and shifts the driving strap on the loose rigger, g^1, when the machine stops of itself. The boy in attendance then draws out the bar, *d*, by its projecting bow-handle, and releases the can, *b*, filled with its coil of compressed yarn, which is removed and replaced by another empty can, to have the same operation repeated.

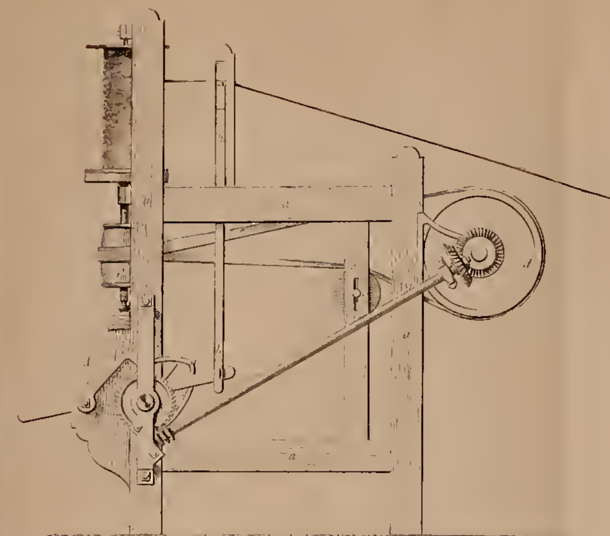
We now proceed to illustrate the winding machine, which is very simple in its construction. It has a twofold object—1st, To separate the four yarns previously coiled together upon each drum in the operation of spinning and doubling, and then wind them a second time upon distinct bobbins or reels; and, 2ndly, By the same operation to reverse the lay of the yarns, so that, in going through the subsequent process, each may follow the same course in which it was spun, otherwise the ends of the fibres would be drawn out, and the strands present a rough and unsightly appearance.

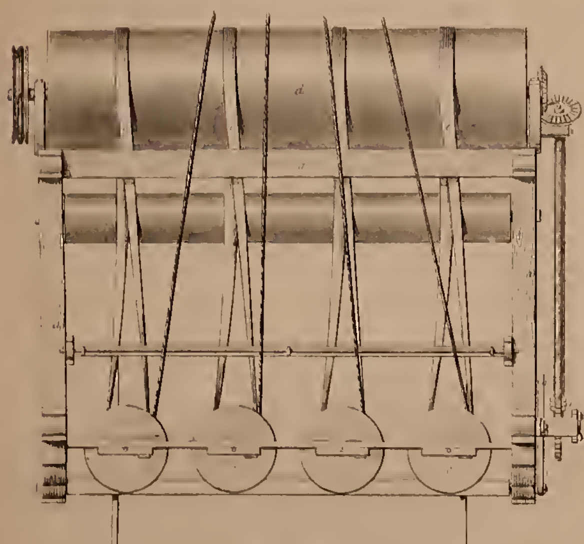
Fig. 1, Plate cxxvi., represents the plan of this machine, Fig. 2 its front elevation, and Fig. 3 its side elevation;—*a*, is the general framework; *b*, live and dead pulleys, fixed on the spindle of the drum, *d*, which traverses the machine: over this drum are four endless straps, *e*, passing also round four small riggers, *f*, fixed upon the vertical spindles upon which the reels or bobbins, *c*, are secured. One of the drums filled with yarn is brought from the spinning machine, and fixed upon a horizontal spindle running loose upon its own bearings, when the ends of the four yarns, *k*, are brought over a bar, *p*, belonging to the sliding frame, *h*, and attached to the reels, *e*. The spindles being now caused to revolve by the arrangements just mentioned, the yarn is made to wind itself upon each reel, and in order that all parts may be filled equally, the yarn is made progressively to rise and fall alternately by a motion contrived for this purpose. Upon the opposite end of the drum-shaft, *d*, from which the power is derived, is a bevel-wheel, *l*, working into a similar one fixed upon an inclined spindle, *m*, having at its lower end an endless screw or worm, which works into and drives a worm-wheel, *n*, and upon the spindle of this is fixed a heart-shaped cam, *g*, upon the periphery of which rests the end of a bent lever, *i*, affixed to the spindle, *k*, that traverses the machine; upon this spindle are two horizontal arms, having their extremities jointed to two upright bars, *h*, that slide in the guides, *o*, and carry the transverse bar, *p*, over which the

Winding Machinery.

Fig. Front Elevation

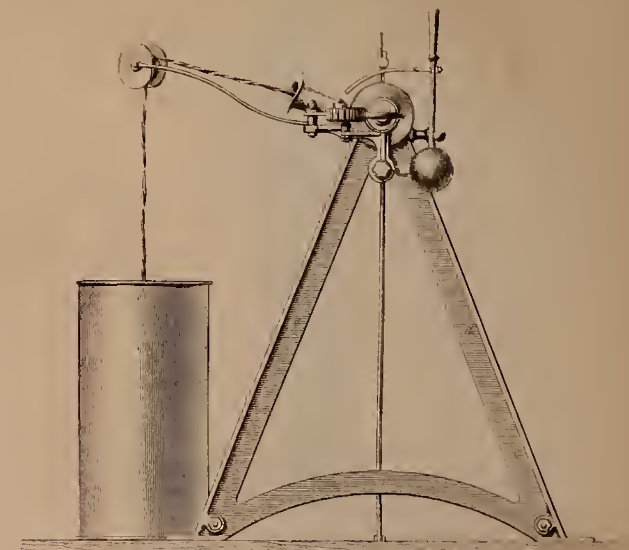






Spinning Machinery.

Fig. Elevation



Sliver Compresser

Scale to Sliver Compresser.

Scale to Figs. 1. 2. & 3.

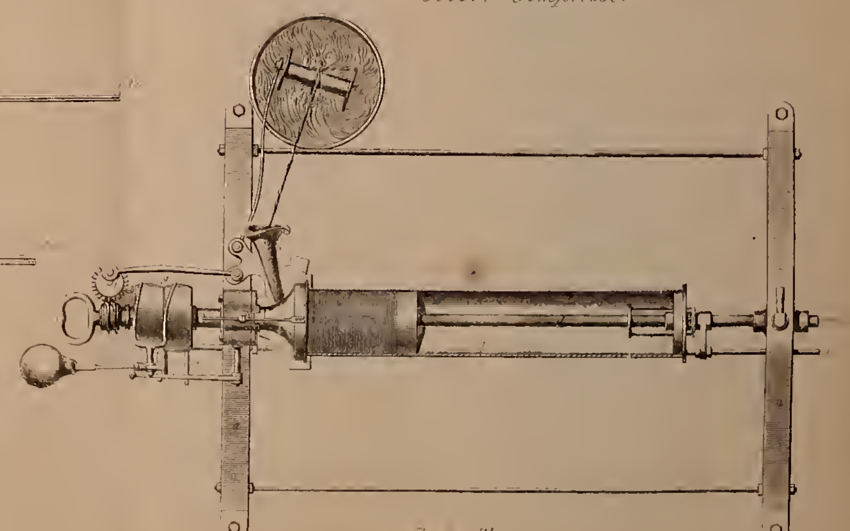


Fig. Plan

W. Smith C.E. delt

yarns pass on their way to the reels: it is therefore evident that the rotation of the cam, *g*, acting simultaneously with the action of the bobbins, must communicate to the bar, *p*, a vertically reciprocating motion, by which the yarns become uniformly wound upon the reels.

Having thus described the progress of the conversion of hemp and flax into threads and yarns, for the purpose of being converted into lines, ropes, and cables, by the system of machines which we have selected for the purpose of illustrating this branch of manufacture, we shall, in accordance with the promise made some time ago, complete the subject under treatment by illustrating the most recent improvements introduced in the various machines employed for preparing and finishing hemp and flax threads and yarns; and we further propose, at the earliest opportunity, to illustrate the further stages of manufacture, and the machines employed therein for converting the machine-spun threads and yards into lines, ropes, and cables.

ENGINES OF THE SCREW STEAM SHIPS "SCAMANDER", "MEANDER," AND "ARAXES."

CONSTRUCTED BY MESSRS. SLAUGHTER, GRUNING AND CO., AVONSIDE IRON WORKS, BRISTOL.

In accordance with the promise we made in The Artizan for June we now give extracts from the log-book of the *Araxes*, and carefully reduced copies of the indicator diagrams taken from the engines of the *Meander*, *Araxes*, and *Scamander*.

The following extracts from the log of the *Araxes* of voyages made between Liverpool and Alexandria, from February 26th to March 3rd, 1858, and between Gibraltar and Malta, March 4th to 8th, and between Malta and Alexandria, March 9th to 12th, will be found useful in judging of the performances of this ship, as giving the results of the three runs between February 26th and March 12th, or about 12 days 16 hours' actual time, and a total distance run of about 3,115 knots; and this is followed by the particulars of the voyage from Alexandria to Beyrout, and of her return voyage from Beyrout, calling at Alexandretta, Alexandria, Malta, and Gibraltar, and returning to Liverpool on the 13th of April last.

ABSTRACT OF PERFORMANCE OF THE "ARAXES" FROM LIVERPOOL TO ALEXANDRIA.

Date.	Hour of Day.	Steam in Boilers.	Vacuum.	Revolutions.	Speed in knots.	Sails on Ship.	Wind and Sea.	Draft of Water.	Coal. Description.	Coal. Quantity consumed.	Distance run in 24 hours.
								Ft. in. Ft. in.			knots.
Feb. 26	12 15 p.m.	19½	24	46	10½	Fore topsail	....	Fore, 17 6 Aft, 19 6	Lancashire	....	....
„ 27	12 0 noon.	18	24½	43	..	Foresail and topsail	....	....	....	....	275
„ 28	7 0 p.m.	16	24	41	11	and fore and aft	....	....	....	....	256
March 1	8 0 a.m.	18	25	41	10	Fore and aft only.	Light (ship rolling a	good deal)	....	....	232
„ 2	8 30 a.m.	17½	25	41	..	„	Heavy swell	....	.. .	....	254
„ 3	12 0 noon.	19	24½	44	..	„	Very heavy swell	....	....	....	258
	5 0 p.m.	18½	25	43	..	„	Arrived at Gibraltar ..		....	....	52

Total distance run from Liverpool to Gibraltar 1327

Time occupied, 124 hours 45 minutes. Average speed per hour, 10·66 knots.

LOG OF RUN FROM GIBRALTAR TO MALTA.

Date.	Hour of Day.	Steam in Boilers.	Vacuum.	Revolutions.	Speed in knots.	Sails on Ship.	Winds.	Sea.	Draft of Water.	Coal. Description.	Coal. Quantity consumed.	Distance run in 24 hours.
									Ft. in. Ft. in.			knots.
March 4	3 40 p.m.	18	25	45	11½	No sails	Light, aft	Smooth	Fore, 17 0 Aft, 18 0	Lancashire	....	....
„ 4	6 45 p.m.	20	25	46	12	Foresail & fore topsail	„	„	....	....	....	....
„ 4	10 15 p.m.	18	25	46	..	„	Fine breeze	„	....	....	....	....
„ 5	1 20 p.m.	19½	24½	42	..	No sails	No wind	Great di	fficulty in keeping steam.	....	....	227
„ 6	8 0 a.m.	19	25	44	7¾	„	Ahead	....	....	....	....	....
„ 6	2 45 p.m.	18½	25	43	10	Fore and aft	Port bow	....	....	....	....	222
„ 7	1 40 p.m.	18	25	42½	..	Foresail & fore topsail	„	Heavy	....	....	....	236
„ 8	1 50 p.m.	17	25	43	..	„	P. quarter	....	....	....	....	253
	6 30 p.m.	Arr	ived	at	Mal	ta.	....	....	....	....	....	30

Total distance run.. 968

Time occupied between Gibraltar and Malta, 98 hours 50 minutes. Average speed per hour, 9·8 knots.

LOG OF RUN FROM MALTA TO ALEXANDRIA.

March 9	9 15 a.m.	19	25	43	..	No sails	Aft	....	....	....	....	....
„ 10	9 30 p.m.	18	25½	42½	..	All sail	Aft, very light	....	....	....	....	244
„ 11	9 30 a.m.	19	25½	44½	..	„	„	....	....	....	....	....
„ 12	9 30 a.m.	19½	25½	44	..	„	....	....	....	....	....	254
	5 0 p.m.	19	25	45	..	No sails	....	....	....	....	....	....
	6 0 p.m.	19	25½	36	..	Eased to take on board	pilot.	....	....	....	....	....

Time from Malta to Alexandria, 80 hours 45 minutes. Distance run, 820 miles. Average speed, 10·1 knots.

SUMMARY OF RESULTS.

Total distance run from Liverpool to Alexandria..	3,115 knots
„ time occupied	12 days 16 hours
Average speed per hour	10·25 knots

Since the preceding extracts from the log of the *Araxes* were made, we have had an opportunity of referring to the log of the same ship on her voyage from Alexandria to Beyrout, and in returning from Beyrout to Liverpool, and the following is a carefully-made abstract:—

LOG OF RUN FROM ALEXANDRIA TO BEYROUT, AND RETURN VOYAGE TO LIVERPOOL.

Month.	Day.	Hour.	Steam in Boiler.	Vacuum.	Revolutions.	Speed in knots.	Distance in 24 hours.	Sail.	Wind.	General Remarks.
March	15	6· 0 p.m.	19½	25	44	11½	......	No sail	Ahead, very light.	Draught of water, 13 ft. forward, 16 ft. 6 in. aft.
,,	16	12· 0 noon	18	..	42	..	160 since 6p.m. 15th	No sail	Ahead	Engines had been eased all night, to avoid
,,	,,	10· 0 p.m.	..	..	44	..	......	Fore trysail & gaff-topsl	Port bow.	[reaching Beyrout in the night.
,,	17	11· 0 a.m.	..	..	42	..	......	No sail	Ahead	*Arrived at Beyrout.*
,,	18	2· 0 p.m.	19	..	43	..	......	No sail	Ahead	*Departure from Beyrout.* Drawing 12 ft.
,,	,,	6· 0 p.m.	19½	25½	45	..	......	No sail	Port bow.	[forward, 14 ft. aft.
,,	,,	11· 0 p.m.	18	26	45	..	......	No sail	Port bow.	
,,	19	8· 0 a.m.	..	..	..	..	......	No sail	Port bow	*Arrived at Alexandretta.*
,,	,,	3· 0 p.m.	19	25	46	..	......	No sail	Ahead, light......	*Departure from Alexandretta.* Drawing
,,	20	10· 0 a.m.	..	25½	44	..	......	No sail	Ahead, light.	[12 ft. forward, 12 ft. 9 in. aft.
,,	,,	12· 0 noon	..	..	43	..	176 since 6p.m. 19th	No sail	Ahead, light.	
,,	,,	12· 0 p.m.	18	..	..	..	......	Fore and aft	Stern bow.	
,,	21	10· 0 a.m.	..	26	45	..	272 last 24 hours	No sail	Ahead, light.	
,,	,,	12· 0 p.m.	..	..	..	..	......	No sail	Ahead, light.	
,,	,,	4· 0 p.m.	..	..	..	..	......	....	....	*Arrived at Alexandria.*
,,	27	5·10 p.m.	..	..	..	11	......	No sail	No wind.........	*Departure from Alexandria.* Drawing
,,	,,	11· 0 p.m.	..	..	43	10	......	No sail	Port bow.	[16 ft. 6 in. forward, 17 ft. 9 in. aft.
,,	28	10· 0 a.m.	18½	25½	44	..	......	No sail	Ahead.	
,,	,,	3· 0 p.m.	20	..	43	9½	200 since 6p.m. 27th	No sail	Ahead.	
,,	,,	10· 0 p.m.	19½	26	44	..	......	No sail	Ahead	Stiff breeze, causing some swell.
,,	29	8· 0 a.m.	18½	25½	43	10¼	......	Foresail,foretopsail&jib	Aft.	
,,	,,	10·30 a.m.	19	25	45	11	250 last 24 hours	Foresail,foretopsail&jib	Aft.	
,,	30	7· 0 a.m.	16	25½	39	..	......	No sail	Strong head wind	Heavy head sea.
,,	,,	5· 0 p.m.	17	..	42	..	202 last 24 hours	No sail	Strong head wind	Not so much sea on.
,,	31	9· 0 a.m.	20	..	45	..	......	No sail	Light head winds	*Arrived at Malta.*
,,	,,	3·45 p.m.	..	24	44	..	......	No sail	Light head winds	*Departure from Malta.*
,,	,,	11· 0 p.m.	..	..	..	..	......	Fore and aft..........	Port bow, light.	
April	1	12· 0 noon	16	24½	38	..	200 last 24 hours	No sail	Port bow, light ..	Great difficulty in keeping steam with the small
,,	,,	3· 0 p.m.	20	..	42	9	......	No sail	Ahead, very strong	[coal taken on board at Malta.
,,	,,	5·30 p.m.	..	..	40	5½	......	No sail	Ahead, full gale ..	Heavy head sea.
,,	2	9· 0 a.m.	..	..	41	6	......	No sail	Ahead, strong....	Heavy head sea.
,,	,,	6·30 p.m.	18	..	39	..	......	No sail	Ahead	Heavy head sea; ship pitching very much.
,,	,,	9· 0 p.m.	..	..	38	..	......	No sail	Ahead	Very heavy head sea; ship pitching and rolling.
,,	3	8·30 a.m.	..	..	41	8½	200 last 24 hours	No sail	Ahead.	
,,	,,	5· 0 p.m.	20	..	42	9	......	No sail	Ahead	Not so much sea on; ship going much better.
,,	4	9· 0 a.m.	19	25	41	9¼	......	No sail	No wind	Not so much sea on; ship going much better.
,,	,,	1· 0 p.m.	16½	..	43	10¾	230 last 24 hours	All, fore and aft	Stern bow........	Clearing fires.
,,	5	10· 0 a.m.	19½	..	44	..	......	No sail	Ahead, strong	No sea.
,,	,,	1· 0 p.m.	20	..	43	..	235	No sail	Ahead, stronger ..	Sea getting up fast.
,,	,,	5· 0 p.m.	18	..	41	..	......	No sail	Ahead	*Arrived at Gibraltar.*
,,	6	5·30 a.m.	14½	23	33	..	......	No sail	Ahead	*Departure from Gibraltar.*
,,	,,	10·30 a.m.	..	..	..	..	*Reached Tangiers*	....	....	Coals so bad that it was quite impossible to keep
,,	,,	12· 0 noon	..	..	..	..	*Left Tangiers* ...	....	....	[any steam without nearly closing the
,,	7	9· 0 a.m.	17½	24½	40	..	......	Fore top sail & fore & aft	Port bow	Heavy swell. [throttle valves.
,,	8	....	15	24	37	..	230	All sail	Port beam	The coal from Gibraltar to Liverpool was so bad
,,	9	....	..	..	38	..	235	All sail	Port beam.	that the vessel fell off in speed nearly 2
,,	10	....	17	24½	32	..	......	No sail	Ahead.	knots; had it not been for this, the
,,	11	....	18½	..	39	..	......	No sail	Ahead.	run from Gibraltar would have been
,,	12	....	18	..	38	..	......	No sail	Ahead.	made in a day and a half less.
,,	13	2·30 a.m.	..	..	..	..	......	....	....	*Arrived at Liverpool.*

The distance run by the ship between Alexandria and Liverpool, including the distance from Gibraltar to Tangiers, was } 3,219 miles
Time occupied in running this distance, deducting stoppages.. 15 days 7 hours
Average speed .... 8·8 knots

From Malta to Liverpool, however, the coals used were of the worst description, and the ship had to contend with strong head winds and heavy sea, as the log will show, during the greater portion of the time.

CONSUMPTION OF COALS, OIL, AND TALLOW.

Consumption of coals taken from the average of all the runs made by these ships = 28 tons of average Lancashire coal. With Welsh coal the consumption is less.

Consumption of oil per day, 1⅛ gallons. This includes the oil burnt in the engine-room lamps.

Consumption of tallow, from 5 to 6 lbs. per day.

The following indicator diagrams, we are informed, were taken at the dates respectively placed against them, and we are assured that they fairly exhibit the ordinary working of the engines.

In the diagrams of the *Scamander* it is stated that the throttle-valve was half closed.

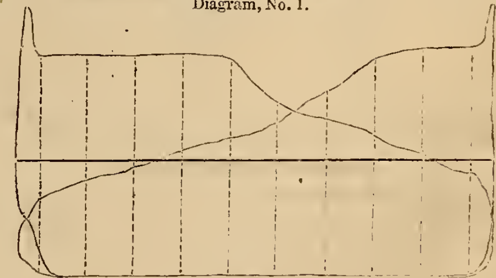
LIST OF INDICATOR CARDS.

Nos. 1 and 2, Cards taken from engines of *Meander*.
,, 3 and 4, ,, ,, *Araxes*.
,, 5 and 6, ,, ,, *Scamander*.

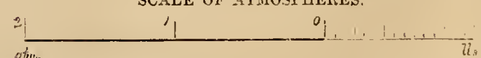
Meander, May 15th, 1857.

Revolutions.. 40
Steam in boilers.. 14 lbs.
Barometer .... 25½ in.
Throttle valve, full open.
2nd grade of expansion; full gear.
Temperature of hot well ....120° Fahr.
Forward engine, top and bottom card.

Diagram, No. 1.



SCALE OF ATMOSPHERES.

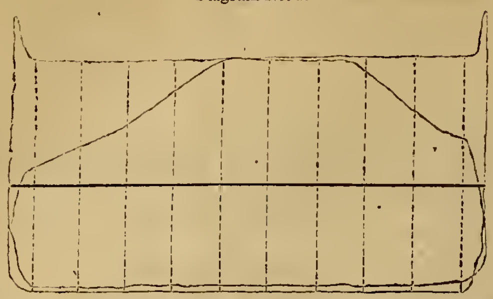


11·5	3·825
11·2	4·200
2)22·7	2)8·025
Mean vacuum..11·35	Mean steam..4·0125

Meander, May 15th, 1857.

Full gear, without expansion; throttle valve full open.
Revolutions 43
Steam in boilers.. 15 lbs.
Barometer .... 25 in.
Temperature in hot well ....120° Fahr.
Forward engine, top and bottom card.

Diagram No. 2.

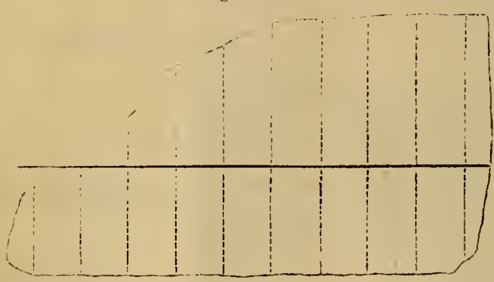


Mean pressure of steam and vacuum................ 20·82.
= 319·6 H.P. for each engine;
= 639·2 H.P. for both engines.

Araxes, April 17th, 1855.

Revolutions.. 48
Steam .... 18 lbs.
Barometer .... $24\frac{1}{2}$ in.

Diagram No. 3.

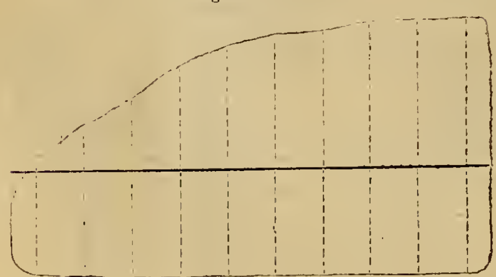


Mean pressure .... 21·1
Total H.P. 723

Araxes, 24th, 1855.

Revolutions.. 46
Steam .... 21 lbs.
Barometer .... 24 in.

Diagram No. 4.

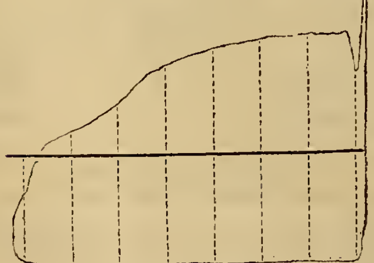


Mean temperature..................................... 21·12
Total H.P. 694

Scamander, April 19th, 1855.

Aft engine; wind, light a-beam.
Revolutions 39
Steam.. 11 lbs.
Barometer.. $27\frac{1}{4}$ in.

Diagram No. 5.



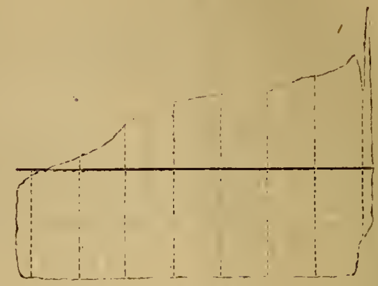
15) 274·8 (18·32
15
124
120
48
45
30

Mean pressure, 18·32 per sq. in.

Scamander, April 19th, 1855.

Forward engine; wind, light a-beam.
Revolutions 39
Steam .... 10 lbs.
Barometer .... 27 in.

Diagram No. 6.



15) 243·6 (16·24
15
93
90
36
30
60

Mean pressure, 16·24 per sq. in.

AN INQUIRY INTO THE STRENGTH OF BEAMS AND GIRDERS OF ALL DESCRIPTIONS, FROM THE MOST SIMPLE AND ELEMENTARY FORMS, UP TO THE COMPLEX ARRANGEMENTS WHICH OBTAIN IN GIRDER BRIDGES OF WROUGHT AND CAST IRON.

By Samuel Hughes, C.E., F.G.S., &c.

(Continued from page 133.)

If we compare now the extensive series of coefficients derived from Mr. Fairbairn's experiments, and those from the "Engineer's Pocket Book," with those for rectangular bars at page 171 of The Artizan, we shall be further convinced how small a positive saving is effected by the use of the flanged girders. It is only in very shallow beams that anything like the proportions from which Mr. Fairbairn's highest results were derived, can practically be obtained. For instance, in the 12-in. girders almost all the examples give proportions nearly resembling 11, 69, 20, which represents Mr. Fairbairn's best experimental beam. In these cases, as might be expected, the coefficients are highest, and are considerably more than those for rectangular beams.

But in all the other examples the coefficients are little, if at all, higher than those for rectangular bars of the best iron. The coefficients for the 24-in. girders range from ·736 to ·917, the lowest of these being actually less than ·750, which is about the least coefficient ever proposed for ordinary rectangular iron, even in castings of the heaviest description.

The following Table will further illustrate the comparatively small value of the flanged girder in an economical point of view. It contains the particulars of most of the actual railway girders quoted in previous pages of The Artizan. To these particulars I have added the coefficient applicable to the whole area, as derived from Mr. Fairbairn's formula and the corresponding one from the "Engineer's Pocket Book."

EXAMPLES FROM TABLE AT PAGE 268 OF THE ARTIZAN.

No.	Whole Area in Square Inches.	Per Centage of Whole Area. Top.	Bottom.	Rib.	Coefficient by form $\frac{2\cdot16\,a\,d}{l} = W$	Coefficient by form $\frac{2\,a\,d}{l} = W$
1	157·5	11	38	51	·823	·760
2	98	10	37	53	·802	·740
3	49·5	9	55	36	1·192	1·100
4	110·	9	33	58	·715	·660
5	69	9	39	52	·845	·780
6	64·5	9	42	49	·910	·840
7	140·	11	40	49	·867	·800
8	86·	12	49	39	1·062	·980
9	65	10	46	44	·997	·920
10	89	8	40	52	·867	·800
			Other Examples.			
Page in Artizan.						
81		10	50	40	1·083	1·000
82		11	38	51	·823	·760
83		9	50	41	1·083	1·000
”		11	33	56	·715	·660
”		13	38	49	·823	·760
”		8	35	57	·758	·700

Now, throughout the whole of this Table, which consists entirely of practical examples, and relates to bridges actually constructed, there is only one case, namely, that of No. 3, in which the coefficient is higher than that determined by Messrs. Fairbairn and Hodgkinson for the best cast iron in the form of rectangular bars. On the other hand, many of the coefficients are less than those which have been used for rectangular bars, even by the most cautious inquirers under extreme circumstances.

It is probable that ·75 is the lowest coefficient ever proposed for rectangular bars. This was proposed by Mr. Robert Stephenson for cast iron exceeding 3 in. in thickness, although he found from his experiments that a mixture of the best iron would give a coefficient of 1·203 (See Mr. Edwin Clark's account of these experiments, in his work before quoted on the Britannia and Conway Bridges).

Now, in the preceding Table, there are several examples of flanged girders, in which, according to the usual formula, the coefficient falls below ·75, while, in many other cases, it is barely above this.

It may be fairly assumed that in none of these cases is the girder weaker than a rectangular beam of the same iron; and yet the formula proposed by Mr. Fairbairn leads inevitably to this conclusion.

All these observations tend to show that our acquaintance with the strength of flanged cast-iron beams is still very imperfect, and that an extensive series of experiments is still wanting to determine the comparative strength of flanged beams and rectangular bars cast from the same iron.

GENERAL EXPRESSIONS FOR CALCULATING THE TRANSVERSE STRENGTH OF BEAMS.

The coefficients which have been determined in the previous articles are commonly those which apply to a beam supported at both ends and loaded in the middle. There are certain circumstances, however, as when the beam is fixed at one end and loaded at the other, in which the breaking weight will be only one-fourth of what has been determined for load in the centre. As we are now about to give a general formula in a comprehensive shape, it will be convenient to use the lowest unit, and hence, let $S = \frac{n}{4}$ or $\frac{c}{4}$, or, in general, one-fourth of the coefficient determined for breaking weight in the centre.

Also, let l be the length in feet of any beam, or distance between supports, when these are used:

W = breaking weight in tons;
A = area of beam in inches;
d = depth in inches;
S = a constant or coefficient = one-fourth of the coefficient for beam supported at both ends and loaded in the middle.

Also, let m and n be the segments of a beam loaded at some intermediate point other than the middle, and let $m + n = l$.

Then the following Table shows the general formula for finding any one of the four, when the other three are given, under the eight separate conditions expressed in the first column.

	Value of W.	Value of l	Value of A.	Value of d.
1. Fixed at one end, and loaded at the other	$\frac{S\,A\,d}{l}$	$\frac{S\,A\,d}{W}$	$\frac{l\,W}{S\,d}$	$\frac{l\,W}{S\,A}$
2. Fixed at ditto, and loaded uniformly	$\frac{2\,S\,A\,d}{l}$	$\frac{2\,S\,A\,d}{W}$	$\frac{2\,l\,W}{S\,d}$	$\frac{2\,l\,W}{S\,A}$
3. Supported at both ends, and loaded in the middle	$\frac{4\,S\,A\,d}{l}$	$\frac{4\,S\,A\,d}{W}$	$\frac{4\,l\,W}{S\,d}$	$\frac{4\,l\,W}{S\,A}$
4. Supported at both ends, and loaded uniformly	$\frac{8\,S\,A\,d}{l}$	$\frac{8\,S\,A\,d}{W}$	$\frac{8\,l\,W}{S\,d}$	$\frac{8\,l\,W}{S\,A}$
5. Fixed at both ends, and loaded in the middle	$\frac{6\,S\,A\,d}{l}$	$\frac{6\,S\,A\,d}{W}$	$\frac{6\,l\,W}{S\,d}$	$\frac{6\,l\,W}{S\,A}$
6. Fixed at both ends, and loaded uniformly	$\frac{12\,S\,A\,d}{l}$	$\frac{12\,S\,A\,d}{W}$	$\frac{12\,l\,W}{S\,d}$	$\frac{12\,l\,W}{S\,A}$
7. Supported at both ends, and loaded at some intermediate point	$\frac{S\,l\,A\,d}{m\,n}$	$\frac{m\,n\,W}{S\,A\,d}$	$\frac{m\,n\,W}{S\,l\,d}$	$\frac{m\,n\,W}{l\,A\,S}$
8. Fixed at both ends, and loaded ditto	$\frac{1{\cdot}5\,S\,l\,A\,d}{m\,n}$	$\frac{m\,n\,W}{1{\cdot}5\,S\,A\,d}$	$\frac{m\,n\,W}{1{\cdot}5\,S\,l\,d}$	$\frac{m\,n\,W}{1{\cdot}5\,l\,A\,S}$

In the preceding Table, S is the breaking weight, in tons, applied at the end of a beam 1 ft. long and 1 in. square, fixed at one end and unsupported at the other. It therefore corresponds with the safe weight in the centre (given at page 171) for a beam supported at both ends.

In a Table which appears in the "Civil Engineer and Architects' Journal" for 1841, and which professes to be founded on the experiments and researches of Tredgold, Galileo, Mariotte, and Girard, the safe load, corresponding with S, has been taken throughout for cast iron at 1·9 cwts. or ·095 tons. Now this is either 1-3rd or 1-4th of the breaking weight, and hence S = ·095 × 3 = ·285, or = ·095 × 4 = ·380.

By referring to page 5 of THE ARTIZAN for January, 1858, and page 171 of the volume for 1857, it will be seen that both these coefficients are much too high, according to Messrs. Fairbairn and Hodgkinson's valuable experiments on rectangular cast-iron beams.

In these experiments the highest value for S, taking the very best kind of cast iron, was only ·292, while the lowest was ·179. The coefficient for the best anthracite iron was ·261, and for the worst ·197.

Looking at the coefficients of other authors (page 171) the value here used for S appears to be based on Tredgold's authority, and it seems further to have been assumed that the beam would bear 1-3rd instead of 1-4th of its breaking weight.

The same Table contains the comparative cohesive strength for various other materials, that of iron being taken at 4·334. Hence, taking the coefficient, or value of S for cast iron, at ·285, we obtain the value of S for any other material by reducing it in proportion to its cohesive strength. In this way the following coefficients have been calculated.

Name of Material.	Cohesive strength = c, that of cast iron being 4·334.	Value of S, or $\frac{{\cdot}285\,c}{4{\cdot}334}$	Value of S, calculated from Professor Barlow's experiments.
Arbutus	1·845	·121	
Red Ash	1·899	·125	·075 (Red Ash and White Ash)
White Ash	1·804	·119	
Bay	1·547	·102	
Beech	1·880	·124	·058
Chesnut	1·291	·085	
Elm	1·432	·094	·038
Fir	1·380	·091	
„ American	0·942	·062	·041
„ Memel	1·154	·076	
„ Red Pine	1.172	·077	·050
„ Riga ditto	0.964	·063	·041 ·039
„ Russian ditto	1.062	·070	
„ Scotch	0·837	·055	
„ Yellow Pine	0·900	·059	
Scotch Larch	0·837	·055	·031 to ·043
Spanish Mahogany	1·283	·085	
Maple	1·123	·074	
Mulberry	1·492	·098	
Oak, American	1·009	·066	·066
„ British	1·509	·099	·044 ·062
„ Baltic	1·211	·080	
„ Dantzic	0·818	·054	·054
„ French	1·450	·095	
„ Provence	1·455	·096	
Orange	1·764	·116	
Pitch Pine	1·284	·084	·061
Plum	1·357	·089	
Pomegranate	1·221	·080	
Poplar	0·705	·046	
Quince	0·841	·055	
Tamarisk	1·194	·079	
Java Teak	1·509	·099	·091 (Java Teak and Malabar ditto)
Malabar ditto	1·395	·092	
Poon	....	....	·083
Adriatic Oak	....	....	·052
Norway Spar	....	....	·055
Experiments made on extraordinary specimens of their several kinds.			
Tonquin Beam	....	....	·143
Locust	....	....	·133
Bullet Tree	....	....	·100
Greenheart	....	....	·110
African Oak	....	....	·096
Acacia	....	....	·069
Oak, fast grown	....	....	·058
„ slow grown	....	....	·039
„ „	....	....	·055
„ superior quality	....	....	·084
Ash	....	....	·076
Elm	....	....	·045
Christiana Deal	....	....	·061
Memel Deal	....	....	·064

Examples showing the use of the Table.

1. Required the weight which a beam of oak will bear when fixed at one end, its length being 4 ft., area 72 sq. in., and depth 12 in.; coefficient, or value of S = ·05.

Here $\left.\begin{aligned} A &= 72 \\ d &= 12 \\ l &= 4 \end{aligned}\right\}$ then $\frac{S\,A\,d}{l} = \frac{{\cdot}05 \times 72 \times 12}{4} = 10{\cdot}8$ tons, the weight

which will break the beam, and $\frac{10 \cdot 8}{4} = 2 \cdot 7$ tons, the safe weight. Also the beam will break with $10 \cdot 8 \times 2 = 21 \cdot 6$ tons equally distributed, and will bear a safe distributed load $= 5 \cdot 4$ tons.

2. Let the same beam be 10 ft. between supports: required the weight it will bear when loaded in the middle, and when loaded uniformly. Here $l = 10$, and all the others remain as before. Then, by line three in the Table, page 159, $W = \frac{4\,S\,A\,d}{l} = \frac{4 \times \cdot 05 \times 72 \times 12}{10} = 17 \cdot 28$ tons, the breaking weight in the centre. The safe weight in centre $= \frac{17 \cdot 28}{4} = 4 \cdot 32$ tons.

The same beam will break with a distributed load of double the above, or $34 \cdot 56$ tons, and will safely bear a distributed load of $8 \cdot 64$ tons.

3. Let the beam be fixed at both ends, and loaded in the middle, all the quantities remaining as before. Then, by the fifth line in the Table, page 159, $\frac{6\,S\,A\,d}{l} = \frac{6 \times \cdot 05 \times 72 \times 12}{10} = 25 \cdot 92$ tons, the breaking weight in the centre; and double this, or $51 \cdot 84$ tons, is the breaking weight distributed.

The safe loads in both cases will be one-fourth the above weights.

4. Let the same beam be supported at both ends, and loaded at a point 3 ft. from the end. Then $m = 7$, $n = 3$; the others being as before, By the seventh line in the Table, $\frac{S\,l\,A\,d}{m\,n} = \frac{\cdot 05 \times 10 \times 72 \times 12}{7 \times 3} = \frac{432}{21} = 20 \cdot 6$ tons, the breaking weight; and $\frac{20 \cdot 6}{4} = 5 \cdot 15$ tons, the safe weight when loaded 3 ft. from the end.

5. Let the beam be fixed at both ends, and loaded as before 3 ft. from one extremity. Then, by the eighth line, $\frac{1 \cdot 5\,l\,A\,d}{m\,n} = W$; or the beam will bear 50 per cent. more than in the last case; namely, it will break with $30 \cdot 9$ tons, and will bear safely $7 \cdot 7$ tons.

It will be unnecessary to give any more examples showing how the length, area, or depth of any beam may be derived, when the weight to be borne and the other quantities have been determined.

HOLYHEAD AND KINGSTOWN MAIL STEAMERS.

As any particulars we may give relating to the above cannot now prejudice the interests of the contracting parties, we propose in the first place to give, from time to time, such of the materials as have been placed in our hands relating to the competitive offers, and the views of the various engineers and steam-ship builders consulted upon the subject; and we proceed to give the letter of one of the celebrated London engineering firms which was written in reply to the circular addressed to the various engineering establishments in Great Britain. We will take an early opportunity of giving such other information of scientific interest upon this subject as we can furnish.

To the Directors, &c., &c.

October, 1857.

Gentlemen,—We have the honour to acknowledge reception within the last week of a copy of your circular of the 9th August, forwarded to us by your Secretary, C. E. Stewart, Esq., requesting information upon the subject of a class of fast steam-vessels proposed to be established on the Packet Station between Holyhead and Kingstown.

The inquiry is one of considerable importance, from the fact of the speed required in the proposed steamers being so far beyond anything that has been attained up to the present time in steam propelling, and, from its intricacy, requires great consideration; we, however, feel confident that our experience and knowledge on the subject will enable us to offer you trustworthy advice and information. It happens that we have already some knowledge of the Packet Service between the ports of Holyhead and Kingstown. About nine years ago we fitted the machinery of the *Caradoc*—one of the Government steam-packets employed for some time on the station in question.

The dimensions, power, and known capabilities of the *Caradoc* have been adopted by us as a data in the investigation of the proposed class of fast steamers. The *Caradoc* is a vessel of about 560 tons burthen, with 350 nominal H.P., but working up to 1,030 indicated H.P., and in smooth water has a speed of 14·81 knots (nautical miles), or $17\frac{1}{4}$ statute miles. In the year 1849 the *Caradoc* made 182 consecutive passages, within the average time of 4 hours 26 minutes, between Holyhead and Kingstown, but accompanied by this important particular, that at least four out of five of the said passages were accomplished within the average time, while not more than one out of five exceeded the above average time. It is here proper to remark that the *Caradoc* is a short vessel compared with her breadth, the length being only $6\frac{2}{3}$ times the beam, viz.: 170 ft. long, $25\frac{1}{2}$ ft. beam, and 9 ft. draft of water; but since that vessel was constructed, the advantages of giving greater proportional length to steam-vessels has been fully acknowledged. There is no valid objection whatever against giving to the proposed first-class steamers a length of at least $9\frac{1}{2}$ times the beam. If the *Caradoc* had been built of such proportions, and confined to same displacement as at present, her speed would have been greater by nearly 1 knot per hour. As will be seen by calculation A, given in the annexed paper. We observe that the proposed class of fast steamers is required to complete the voyage within the time of three hours and three-quarters, except on extraordinary occasions. A vessel capable of making four out of five passages within three hours and three-quarters should have a proportionate greater speed than the *Caradoc*—say $17\frac{1}{2}$ knots, and with a speed of 18 knots would certainly be capable of completing nine passages out of ten within the given time; and this we presume will be considered as a reasonable fulfilment of the requirements contained in your circular letter.

To accomplish fully the object sought, we find that it will be necessary to have a steamer of at least three times the magnitude of the *Caradoc*, with a corresponding power; the length to be $9\frac{1}{2}$ times the breadth of beam, viz.:—325 ft. long, 33 ft. beam, 11 ft. draft of water, 1,000 nominal H.P., but working to 4,000 indicated H.P. A vessel of these dimensions and power will have a speed of $18\frac{1}{2}$ knots, or $21\frac{1}{4}$ statute miles per hour, as will be seen by inspecting the calculation B.

We submit to you on the accompanying paper the solution of this important problem, together with the calculation in full. We also submit the six propositions, which, with these demonstrations, serve as a groundwork or basis of the whole investigation. We submit these in the hope that you will direct them to be scrutinised by competent authority, as we feel confident that the calculations we have drawn from the best information possessed on the subject cannot be successfully controverted. It only remains for us to add that if the information given by us is found worthy of confidence, we venture to hope being honoured with an order for the machinery of one or two of the proposed vessels.

Your obedient servants,

———————.

The Calculation referred to in the above Letter, dated October, 1857.

This calculation is grounded, in the first place, upon the six propositions which are given further on, which bear directly upon the inquiry under consideration, and which propositions, with their demonstrations, it is confidently presumed will be found to be in strict accordance with sound reasoning and well-established experience, although in some particulars differing with the popular views on the subject; and in the second place, this calculation is based upon the actual performance of the Government steam-packet *Caradoc*, employed about eight years back on the above-named station. This vessel, tried in smooth water, has a speed of 14·81 knots per hour, and in the year 1849 made 182 consecutive passages between the ports of Holyhead and Kingstown in the average time 4 hours 26 minutes each passage. With the data furnished by this vessel, an investigation is here given for a class of vessel that shall have a speed of at least 18 knots per hour, or 21 statute miles. It should be observed that the *Caradoc* is a short vessel, the length being about six and a half times the beam of the vessel. Our experience shows that steamers of a much greater comparative length, with the same displacement and same power, will have a great increase of speed, and can be employed in any such service with perfect success and security. If the length of the *Caradoc* had been nine and a half times, her speed would be nearly 1 knot per hour greater, as will be seen by the calculation A, which is a comparison of the *Caradoc* in her present form with a vessel of the same displacement and same general form, but different in type, *i. e.*, the length being nine and a half times the breadth, instead of six and two third times only: that is, an elongated *Caradoc*. The dimensions, power, &c., of the two vessels are given in the two columns as under:—

Caradoc as her present type.		*Caradoc* elongated.
170 ft. long } $6\frac{2}{3}$.	Put A = sectional area.	219·421 length.
$25\frac{1}{2}$ ft. beam }	l = length.	23·097 beam.
9 ft. draft.	b = beam.	7·699 draft.
	d = displacement parallel.	
39·015 parallel.	P = power.	39·015 = parallel.
230 sectional area.	B R = bow resistance.	177·8 = sect. area.
	S R = surface resistance.	
*515 bow resistance.	v = speed.	1,030 = Ind. H.P
515 surface do.		

1030 total surface resistance = power.
350 nominal H.P. = 1,030 indicated H.P.

* The bow resistance of the *Caradoc* in this case is here assumed to be equal to the surface resistance, and each equal to $\frac{1}{2}$ indicated H.P. Now from the above data we have in the first place to determine the

amount of resistance which will oppose the elongated *Caradoc* when moving with a speed of 14·81 knots. But the bow resistance will be as $\frac{A \times b^2}{l}$. See third proposition: that is—

$$\frac{230 \times 25{\cdot}5^2}{170} : 515 :: \frac{177{\cdot}8 \times 23{\cdot}097^2}{219{\cdot}421} = 253{\cdot}1 = B\,R;$$

and for the surface resistance as $b \times b$,

$$170 \times 25{\cdot}5 : 515 :: 219{\cdot}421 \times 23{\cdot}097 = 602{\cdot}1 = S\,R$$

Total resistance 855·2

$$\begin{array}{rl}
23{\cdot}097^2 = & 1{\cdot}36354 \\
 & 2 \\ \hline
 & 2{\cdot}72708 \\
177{\cdot}8 = & 2{\cdot}24996 \\ \hline
 & 4{\cdot}97704 \\
219{\cdot}421 = & 2{\cdot}34128 \\ \hline
 & 2{\cdot}63576 \\
515 = & 2{\cdot}71181 \\ \hline
 & 5{\cdot}34757 \\
25{\cdot}5^2 = & 1{\cdot}40654 \\
 & 2 \\ \hline
 & 2{\cdot}81308 \\
230 = & 2{\cdot}36173 \\ \hline
 & 5{\cdot}17481 \\
170 = & 2{\cdot}23045 \\ \hline
 & 2{\cdot}94436 \\ \hline
253{\cdot}1 = & 2{\cdot}40321 = B\,R
\end{array}
\qquad
\begin{array}{rl}
219{\cdot}421 = & 2{\cdot}34128 \\
23{\cdot}097 = & 1{\cdot}36354 \\ \hline
 & 3{\cdot}70482 \\
515 = & 2{\cdot}71181 \\ \hline
170 = 2{\cdot}23045 & \\
25{\cdot}5 = 1{\cdot}40654 & 6{\cdot}41663 \\ \hline
3{\cdot}63699 = & 3{\cdot}63699 \\ \hline
602{\cdot}1 = & 2{\cdot}77964 = S\,R
\end{array}$$

Therefore, the total resistance of elongated *Caradoc* will be reduced from 1030 to 855·2, being a reduction of about one-sixth of the resistance. But the same speed of 14·81 knots will be obtained by the elongated *Caradoc* by a power = to the reduced resistance—viz., 855·2 H.P.; but we shall still have the full power as before—viz., 1030 horses, ∴ the speed of the elongated *Caradoc* will be as the cube root of these respective resistances, $v = P^{\frac{1}{3}}$. See proposition.

$$855{\cdot}2^{\frac{1}{3}} : 14{\cdot}81 :: 1030^{\frac{1}{3}} = 15{\cdot}76$$

That is, the speed of the elongated *Caradoc* will be increased to 15·76 knots in place of 14·81, a gain of nearly one knot per hour.

$$\begin{array}{rrl}
 & 1030^{\frac{1}{3}} = & 3)3{\cdot}01284 \\ \hline
 & & 1{\cdot}00428 \\
 & 14{\cdot}81 = & 1{\cdot}17056 \\
 & 2 & \\ \hline
855{\cdot}2^{\frac{1}{3}} = & 2{\cdot}9320 & 2{\cdot}17486 \\
 & & 0{\cdot}97738 \\ \hline
 & 15{\cdot}76 = & 1{\cdot}19744
\end{array}$$

We have now to determine the size (capacity), dimensions and power of a steam-packet that shall have a speed of 18 knots and upwards in smooth water. This cannot be accomplished in any convenient or satisfactory way, except by considerable increase in the capacity and power of the vessel. Now, adhering to the type of the elongated *Caradoc*, let the proposed vessel be increased to three times the displacement of that vessel, with increased power in proportion, that is, 1,000 nominal H.P., instead of 350, but working up to 4,000 indicated H.P. Let the dimensions of proposed vessel be :—

325 ft.	length
33 „	beam
11 „	draft independent of keel
117·971 „	parallel
363	sectional area
4000	indicated H.P.

If the above data of the large vessel be compared with those of the elongated *Caradoc* already given, we shall be able to determine the resistance of the former when moving at the same speed of 14·81 knots per hour, and for bow resistance it will be as displacement as d, *Caradoc* displacement:—

As 39·015 : 253·1 :: 117·975 = B R of large vessel ... 765·3
And for the surface resistance as b^2:—
23·097² : 602·1 :: 33² = S R of large vessel = 1229·1

Total resistance 1994·4

$$\begin{array}{rl}
117{\cdot}975 = & 5{\cdot}07118 \\
253{\cdot}1 = & 2{\cdot}40321 \\ \hline
 & 7{\cdot}47509 \\
39{\cdot}015 = & 4{\cdot}59124 \\ \hline
765{\cdot}3 = & 2{\cdot}88385 = B\,R
\end{array}
\qquad
\begin{array}{rrl}
 & 33^2 = & 1{\cdot}51851 \\
 & & 2 \\ \hline
 & & 3{\cdot}03702 \\
 & 60{\cdot}21 & 2{\cdot}77964 \\
23{\cdot}097^2 = & 1{\cdot}36354 & \\
 & 2 & 5{\cdot}81666 \\ \hline
 & = & 2{\cdot}72708 \\ \hline
 & 1229{\cdot}1 = & 3{\cdot}08958 = S\,R
\end{array}$$

From which it appears that the large class steamer, moving at the rate of 14·81 knots per hour, will have a total comparative resistance of 1994·4; but the large vessel will have a power of 4,000 horses, which is equal to a resistance of the same amount, ∴ the speed of this vessel will be increased in the ratio of the cube root of these respective resistances.

$$\text{As } 1994{\cdot}4^{\frac{1}{3}} : 14{\cdot}81 :: 4000^{\frac{1}{3}} = 18{\cdot}68$$

$$\begin{array}{rl}
4000^{\frac{1}{3}} = & 3)3{\cdot}60206 \\ \hline
 & 1{\cdot}20069 \\
14{\cdot}88 = & 1{\cdot}17056 \\ \hline
1994{\cdot}4 = 3)3{\cdot}29984 & \\
 & 2{\cdot}37125 \\
1{\cdot}09995 = & 1{\cdot}09995 \\ \hline
18{\cdot}68 = & 1{\cdot}27130
\end{array}$$

Therefore, the proposed vessel will have a speed of 18½ knots per hour, or 21½ statute miles; which it is presumed will be ample to satisfy the requirement of completing the voyages between Holyhead and Kingstown at all times, except on extraordinary occasions.

THE RIVER THAMES AND LONDON SEWERAGE.

MUCH vexed as the important question of the sewerage of London has been for these last few years, and numerous as have been the schemes proposed for the solution of this great sanitary problem, it is probable that under the fostering care of Government commissioners' reports, and committees of enquiry, it would have continued to drag its slow length along interminably, whilst the principal object connected with it — the river Thames — remained a source of unceasing pollution to the atmosphere of the metropolis, and of detriment to the health and comfort of nearly three millions of souls, had not this, like most other great and crying evils, ultimately reached the point at which arises the tendency to cure themselves. A week of broiling hot weather in June has done more in awakening in the minds of the public of all classes a proper sense of the necessity for dealing promptly with the present condition of the Thames, than all that has been said and written by committee-men, engineers, and chemists. The filthy aspect of the water, and the abominable stench arising therefrom, have proved arguments more convincing than any abstract reasoning could offer: "*nihil est in intellectu quod non fuerit in sensu*," is proved to be true in this as in a thousand other cases, where familiarity with an established evil causes it to be treated with indifference, until, by the operation of some unusual influence, we are suddenly reminded sensually of its existence. The operation of the hot summer sunshine has now proved an effective means of bringing home to the minds of all, through the medium of nose and eyes, the conviction that the purification of the Thames, by one means or another, is a work not to be longer delayed, if we value our own health, as well as that of the immense mass of human beings congregated in overgrown London. There is, however, no longer any disposition to trifle with this most important question; the public mind has taken alarm; it is clear that such enormous volumes of stinking and poisonous effluvia poured into the atmosphere in the manner we have lately witnessed, may produce the most direful effects. The question is now, not whether measures should be immediately taken to effect the purification of the river, but what those measures should be, and how most speedily to render them operative, whatever they may be.

In devising a plan for dealing with an evil so great and so fraught with danger as that under consideration, the first step naturally consists in ascertaining, as closely as possible, wherein it immediately lies; and it appears that, with reference to the present state of the river, there is no difficulty in complying with this proposition.

It will of course be at once admitted that the great source of pollution to the Thames is the immense flood of fœtid sewage poured into it at every state of the tide—the excretiæ of 2,600,000 human beings, to which must be added a great amount of offal and refuse organic matter of various kinds are daily and hourly finding their way into the river, which becomes, indeed, the arterial sewer of the metropolis. But the great evil of all is not here; it is to be sought and found in the state of the banks and bed of the river itself. It is true that the influx of millions of gallons of sewage daily into the waters of the river is a

subject which commands serious consideration, and which ought to be remedied; but this, as a means of producing poisonous, health-destroying miasmata, is a trifle compared with the state of the river banks—those hotbeds of festering decomposition, which, when uncovered by the water and exposed to the action of the sun, are ever sending into the air fruitful germs of disease and death. The slimy mud which covers the Thames banks for miles along its course, and which is composed partly of the diluvium of the river, and partly of matter brought into the water by the sewers, contains, by analysis, from 15 to 20 per cent. of organic matter, yielding, on the whole weight of the dried mud, about 1 per cent. of nitrogen. Alternately covered and uncovered by the flow and ebb of the tide, this organic matter is placed in the most favourable condition to undergo rapid chemical decomposition; and when, to assist in developing this natural tendency, we have a tropical temperature, as we have had in the second and third weeks of the past month, it may be well believed that the mud banks of the Thames have been during that time especially, and are in lesser degree at all times, elaborating subtle blood poison, which, even if it be not the cause of a great and fatal epidemic, must produce a slower, but not less certain effect—sapping the strength of the population, and lowering the general standard of the public health.

Although the presence of the sewage in the water of the Thames is undoubtedly a great evil, converting as it does a noble stream of pure water into something resembling a dirty ditch, so far as the sanitary question—which is indeed the more important—goes, it is altogether a matter for secondary consideration. It is well known that running water is a most powerful means of preventing the fœtid decomposition of organic matter contained in it, and that by the combined influence of the water and air, to which quickly-moving water exposes a very great and constantly-changing surface, an enormous quantity of decomposing organic matter can be disinfected and purified; it is only in stagnant water and moist mud that the reverse action occurs. Both microscopic and chemical examination prove that the water of the Thames in mid-river does not contain a great excess of organic matter, dead or living, not more than may be rendered completely innoxious by the operation of the natural agents—water and air; in a sanitary point of view, therefore, it is not the water of the river which demands attention. As we have already shown, the state of the river banks is the source of all the difficulty, and even under much more favourable circumstances, so far as the water is concerned, unless the form and character of the banks and bed of the river be altered, no permanent good can be done. These banks as they now exist are always covered with deposit from the river, which deposit contains, as we have seen, about 20 per cent. of organic decomposable matter. The lighter organic matter, and that soluble in water, remain in the river. It may be said that by the flow of the tide that matter which has been washed away from London at one time is brought back at another, and so by the regurgitation of the stream is, as it were, held oscillating within the metropolitan precincts until, by dissolution into the gaseous form, it is made capable of absorption by and removal into the atmosphere. This is not, however, quite the truth: the ebb of the river exceeds the flow in rapidity by about one mile per hour. This effect is of course due to the initial flow of the stream, independently of the tidal action; the consequence of it is that sewage, and every other impurity contained in the river water, is carried every hour one mile further towards the sea than it can by any possibility be brought from the sea, and this constitutes in itself a powerful "Nuisances Removal Act," but it is after all not a means of removing the great nuisance of all—the mud-banks themselves.

Can nothing be done, then, to deal with the real cause of discomfort and danger? Must these foul, stinking hotbeds of noxious gases and unpleasant odours be suffered ever to remain uncleansed in the midst of London? The remedy appears to be less difficult than would at first sight be expected, and far less costly than the great project of removing the whole mass of the sewage into Sea Reach, to say nothing of the innate defects of that scheme, the ultimate success of which is, at least, problematical. The first step towards removing the real source of danger and annoyance must be directed towards an alteration in the river banks; the second, to changing or modifying the system by which the sewage is discharged into the river. In the first place, by the present state of the banks the scour of the river is impeded, and the tendency to the deposition of organic and inorganic matter, suspended in the water, promoted to the utmost. The stream, which is under 800 ft. wide at Westminster, becomes 1,400 ft. at Hungerford, and is again contracted to about 750 ft. at London Bridge,—a state of things which, under favourable circumstances, must interfere greatly with the power of the current to cleanse its own bed, and which, as the banks at present exist, adds immensely to the difficulty. The remedy here is obviously the narrowing in of the stream in a uniform manner by a proper embankment on each side, so as to reduce the section of the bed of the river to something like a regular form, and at the same time increase the scour by increasing the velocity of the current, while we remove the flat banks, which act as convenient recipients of the deposit from the water; or otherwise, according to Mr. Gurney's proposal, artificial banks of gravel should be constructed at such an angle that the mud cannot be deposited upon them, but would naturally pass towards the centre, whence it would be removed by the scour of the stream.

With the present system of discharging the sewage, no plan relating to the construction of the banks of the river could, however, prove of any real utility. When the sewage is once mingled with the water, it becomes comparatively innoxious; but while undiluted sewage is suffered to pour at low tide over shelving banks of mud, exposed for hours daily to the action of sun and air, rotting and sending volumes of poisonous effluvia into the atmosphere, there is little hope for an improved state of the river itself. It surely cannot, however, be a work of great difficulty to devise a means of correcting this part of the evil. The sewers may all be made to debouche in the stream itself, below low-water mark, as has been already done in the case of the Fleet sewer. By these means the sewage is never exposed to the atmosphere at its place of exit from the sewer, but, mingling with the running water, is diluted largely as it enters the river, and becomes at once comparatively harmless.

The experience of the last week or two has demonstrated in a manner not likely to be forgotten that some remedy must be applied speedily to the state of the river. Year after year the Thames has continued to roll his polluted waters through the heart of London; but the moment seems to have at length arrived when measures—practical, effective measures—not such trifling as throwing into the stream a couple of hundred tons of lime—must be adopted to meet a great and serious evil; and public attention and public fear being thoroughly aroused, we may hope that, at some not far distant period, Londoners will lose the unenviable distinction of living upon the banks of the dirtiest river in the world.

MARINE ENGINE GOVERNORS.

We have attempted frequently to convince steam-ship owners of the necessity for applying a governor to marine engines, and have pointed out the advantages which would arise to them from adopting a thoroughly reliable governor, and we are pleased to have it in our power to lay before our readers the following letter, addressed to the agents for Silver's marine governor:—

Steam-ship "Tantallon," Port of Leith, 28th May, 1858.

To Messrs. Hamilton and Grandison, of Glasgow, the Agents for Silver's Marine Governor.

Gentlemen,—Our passage between Leith and Hamburgh, from the 19th to the 21st inst. inclusive, was exceedingly rough, and gave us a very good opportunity for trying the capabilities of the regulator which you placed on the engines of our ship.

As the sea became rough, the engines commenced racing in the usual manner under the circumstances, but on connecting the regulator, they assumed a regularity of motion with full speed; and for the purpose of ascertaining more positively that this action was secured by means of the regulator, we disconnected the latter, when the engines started again into a confused motion, that required at once a permanent reduction of the steam power for the safety of the machinery, which necessarily reduced the speed of the ship; we then reconnected the regulator, when the engines resumed their regularity of action, and the ship her full speed. This experiment was repeated with the same result, and we have, therefore, no doubt of its fully answering all the purposes intended by the inventor.

The economising of time, as also of steam, by the proper application of the latter, is obvious in all cases where the resistance to an engine varies; and the importance of being able to maintain the full power of the engine when steaming about our dangerous coasts in rough weather, is of the highest consideration, and we congratulate you on your successful application of a device that is so well calculated to effect the desired end.

Very truly yours,
(Signed) B. Cooper, Master.
Charles Roxburgh, Chief Engineer.

Nothing can be more clearly demonstrated than the advantages which the officers of the *Tantallon*, after repeatedly testing the governor, found unmistakeably belonging to it. We would advise the underwriters and the marine insurance companies to interfere and insist upon the adoption of some governor, or, where none is adopted, charge a higher rate of insurance.

Many of our readers will remember the difficulty which pertained to the introduction of life-boats into the mercantile marine, and also of a better means of lowering ships' boats, &c., which Clifford introduced, but which was discountenanced and cold-shouldered by not only the general mercantile, emigration, and transport services, but also by the Admiralty, until, after repeated trials and almost unheard of exertions on the part of Mr. Clifford, it has now almost passed into a law, that no emigrant vessel or ship taken up by the naval transport service shall go to sea without a certain number of the boats being fitted with the boat-lowering apparatus.

Now the introduction of marine engine governors must in like manner be insisted on. Coercive measures must be employed, if voluntary action be not taken in this matter by steam-ship owners. We hope they will see their interest early, and avoid the necessity for coercion.

BISHOP'S PATENT DERRICK.

The first vessel belonging to the company established for working Bishop's Patent was launched at Charlton about the end of May last, and the derrick apparatus and hoisting and propelling machinery has since been fitted on board, and several experimental trips have been made with a view to test the capabilities of the vessel and the machinery. Nothing could be more satisfactory than the mode in which the great queer-looking mass of floating woodwork designated the vessel or "scow" was managed under steam. She steered like a yacht, and turned and twisted about in the river perfectly under the control of the helm.

The dimensions of this "derrick" are as follow:—

General Outline of Power and Dimensions of Patent (Floating) Derrick A (of Wood).

Power:—Hoisting capacity, 100 tons; gear for ditto, three sets of crabs independent of each other, worked by the engines used for propelling; propelling power, one pair of oscillating engines, of 160 nominal H.P., with Barran's patent cup-surface boilers. Dimensions:—Length, 85 ft.; breadth, 43 ft.; depth, 9 ft.; height from deck to boom, 71 ft.; ditto of kingpost above boom, 42 ft.; total ditto, 113 ft.; radius of boom, 52 ft. This machine is capable of depositing its load anywhere within a circle whose diameter is 104 ft. Tonnage of vessel, 600 tons. The whole of the machinery for the above vessel manufactured by Messrs. R. and T. Hughes, New Cross, Deptford.

Since this derrick was launched, she has been employed in various hoisting operations; amongst others the Company engaged to raise four boilers of about 35 tons each from the wharf of Messrs. Humphrys and Co., Deptford, and place them on board barges lying in the river. This was performed in a masterly manner, and the Company are now engaged in an attempt to raise the *Lightning* brig, sunk off Erith, laden with 300 tons of granite.

For many months past an enormous iron vessel or "scow" has been in course of construction at the Thames Iron Shipbuilding Works, Blackwall. This vessel will be surmounted by an enormous iron tower or "crow's nest," with a wrought-iron horizontal boom, about 60 ft. radius, fitted with hoisting tackle capable of lifting 600 tons dead weight.

TRIAL TRIP OF THE "ADMIRAL."

The following particulars have been supplied by a correspondent in Glasgow. This steamer has been built by Mr. James R. Napier, for a Riga company, to ply between Riga and St. Petersburg, and more than ordinary importance attaches to her trial. The ordinary practice of building steamers to specifications, binding the builder down to precise measurements and proportions, whilst the risk as regards speed and consumption of fuel is borne by the purchasers or owners, has been departed from in this instance, and with undoubted advantages to both parties. On undertaking to build the *Admiral*, Mr. Napier guaranteed that she should have accommodation for 80 first-class passengers, 25 second-class passengers, and about 30 officers and crew: that the capacity for cargo should be about 25,000 cubic feet; that the draught of water, when loaded with 90 hours' fuel, 200 tons weight of cargo, and 300 passengers and crew, with provisions and luggage, should not exceed 7 ft. 9 in.; and that the speed in smooth water, when so loaded, should be between $11\frac{3}{4}$ and 12 knots or nautical miles per hour; and, finally, that the consumption of fuel, when running with the above draught and at the above speed, should not exceed 3 lbs. per indicated H.P.

The following Report, drawn up by Professor Macquorn Rankine for the owners, will show how these conditions have been fulfilled:—

"REPORT ON THE PADDLE STEAM-SHIP 'ADMIRAL.'

"Having inspected the steam-ship *Admiral*, and tested her speed, power, and consumption of coal, during a trial-trip on the 11th June, 1858, I have to report as follows:—

"First. As to the Load and Draught of Water.—I have ascertained from authentic vouchers that, previous to 7th June, there had been put on board the ship, by Messrs. Black and Henderson, 315 tons of coals, of which there were consumed during a preliminary trip on that day 10 tons, leaving 305 tons on board. The draught on the 11th June was 7 ft. 5 in.

"Secondly. As to the Speed in Smooth Water.—The speed was tested by running down the Frith of Clyde from Cloch Lighthouse to Cumbrae Lighthouse, and returning from Cumbrae Lighthouse to Cloch Lighthouse. The distance between these points is 13 nautical miles and two-thirds. The downward run took place at about quarter-ebb of the tide; the upward run at about half-ebb. Hence the current was favourable during the downward run, and adverse during the upward run; and the adverse current was stronger than the favourable current—so that on the whole the effect of the tide was to make the apparent speed of the ship seem less than her true speed, but to what extent it is impossible to compute exactly. In the following calculation the speed is given without any addition on account of the tide:—

	H.	M.	S.			
Running Down.						
Passed Cloch Lighthouse	12	16	50			
Passed Cumbrae Lighthouse	1	21	38			
Difference				1	4	48
Running Up.						
Passed Cumbrae Lighthouse	1	51	23			
Passed Cloch Lighthouse	3	4	53			
Difference				1	13	30
Total time of running $27\frac{1}{3}$ nautical miles				2	18	18

Being at the rate of 11·87, or eleven nautical miles and eighty-seven one hundredth parts per hour.

"Thirdly. As to the Power of the Engines.—From a series of nine indicator diagrams carefully taken, I have computed that the power of the engines, for the speed and with the load already stated, is 744 indicated H.P.

"Fourthly. As to the Consumption of Fuel per Hour.—The coal to be burned during and after the trial of speed was placed in bags, each containing 2 cwt., so that the weight consumed in a given time could be ascertained. The combustion of the fuel, so portioned out, commenced at 12·35, at which time I observed the condition of the fires, and continued both during the trial of speed and for a subsequent period—the full speed being still kept up, until 64 cwt. had been burned; the fires being as nearly as I could judge in the same condition as at first. This took place at 3·50 P.M., so that the combustion was at the rate of 64 cwt. in 3 hours 15 minutes, or 2,206 lbs. per hour, being somewhat less than one ton per hour.

"Fifthly. The Consumption of Coal per indicated H.P. per hour was at the rate of 2·97 lbs., or two pounds and ninety-seven one hundredth parts.

(Signed) "W. J. Macquorn Rankine."

The following are the principal dimensions of the *Admiral*, as given in the builder's certificate:—Length, 211 3-10th ft.; breadth, 32 1-10th ft.; depth, 11 9-10th ft.; gross tonnage, 586 12-100th tons; space occupied by engines and 90 hours' coal, 92 33-100th tons; register tonnage, 447 62-100th tons; her extreme breadth over the paddles is 50 ft.

There is no doubt that the engines will improve as they continue to work; yet nothing could be more satisfactory than the results already obtained. The owners have what they bargained for, with full measure, whilst Mr. Napier is not giving away materially more than he is paid for. The nearness with which results have verified the calculations made is something wonderful, and yet in these calculations so little margin was left, that if a deficiency had occurred in any one of the elements necessary to the vessel's success, every other element would have been thrown wrong. Thus a greater consumption of fuel would have necessitated a greater weight of coals, which would involve diminished cargo space or increased draught.

At the preliminary trial on 7th June (referred to in Professor Macquorn Rankine's report) there were 150 men on board in addition to the 315 tons of coals, and the average speed obtained between the Cloch and Cumbrae lighthouses, down and up, was 12 1-10th knots or nautical miles per hour.

The engines, which are patented by Messrs. Randolph, Elder, and Co., have two cylinders $48\frac{1}{2}$ in. diameter, and two cylinders $76\frac{1}{2}$ in. diameter, the stroke of all four being 51 in. The steam is admitted into the smaller cylinders during less than half the stroke, and expands during the remainder of the stroke in the small cylinders, afterwards entering and working in the large cylinders. The paddle-wheels have each eleven feathering floats 7 ft. by 3 ft., the diameter between the centres of two opposite floats being 20 ft. 6 in. During the runs on the 11th the engines averaged $23\frac{1}{4}$ revolutions per minute. The machinery worked with remarkable smoothness, and the concussion or tremor produced by the action of the paddles was unusually slight.

The ship is modelled in accordance with what is known as the "wave theory," and her bows are carried up almost vertically from the water line, whilst her extreme stern is much less overhung than is usual, so that her external appearance is very novel and striking. Her saloon and cabins are very chastely and beautifully decorated, the panels bearing appropriate nautical devices in imitation walnut-wood on bird's-eye maple, which last-named wood generally predominates, being relieved by beads and mouldings of rich-tinted rose and other woods. We may add that the fuel used was Scotch coal.

LAUNCH OF THE "HUDSON" IRON STEAM-SHIP.

This magnificent iron steam-ship—the largest that has been built on the Tyne—was launched from Messrs. Palmer and Co.'s works at Jarrow early in June. She is built for the North German Lloyds, and is one of four ships intended to run between Bremen and New York, two having been ordered on the Tyne and two on the Clyde.

Her dimensions are 345 ft. over all; 40 ft. beam; 26 ft. deep; burthen, 3,000 tons. The engines are 700 nominal H.P., and her bunkers will carry 1,000 tons of coal. She has capacity for 1,000 tons of cargo. It is expected she will steam 14 knots per hour. She can well accommodate 100 first-class and 400 third-class passengers.

She is fitted with eight boats, four of which are Francis's Patent Corrugated Metal Life Boats, each 26 ft. long, 7 ft. 6 in. broad, and 4 ft. deep. These life-boats have been described in The Artizan.

ROYAL INSTITUTION OF GREAT BRITAIN.

April 16, 1858.

The Duke of Northumberland, K.G., F.R.S., President, in the Chair.

ON THE CONDITIONS WHICH DETERMINE THE PROBABILITY OF COAL BENEATH THE SOUTH-EASTERN PARTS OF ENGLAND.

Robert Godwin-Austen, Esq., F.R.S., and G.S.

Fossil fuel may be of any geological age; seams and traces of it have often encouraged researches amongst the tertiary strata of the London basin. Even within the last few years there has been a Woking Heath coal mining adventure; and it has long been a matter of popular belief that Blackheath is to

supply London with coal. There are, however, thick accumulations of tertiary fuel, of which Bovey, in South Devon, is the best example in this country. There is coal belonging to the period of the chalk—there have been innumerable trials for coal amongst the fresh-water formations of the Weald of Kent, Surrey, and Sussex—there is tolerable coal associated with the oolitic series of Yorkshire; but the coal to which the following speculations refer is that which is derived from what have been designated the "true coal measures."

The period to which this coal belongs in the earth's history is of very great antiquity; but the usual way of representing its age, by reference to a vertical scale of geological formations, is inapplicable in the present case; and the only way in which it can be stated is this, that the whole series of formations which may be seen in the cliffs of the south coast of England, from Torbay to the Isle of Wight, have been accumulated since the period of the "true coal" series.

The superficial extent of the carboniferous series in this country is very great. Allowing for what has been denuded, and what we know is covered up, it may be described as extending in a broad band from Berwick diagonally across the whole island into South Wales, and thence across the county of Devon.

The usual subdivision of the great carboniferous series into a descending series of "coal measures," "mountain limestone," and red sandstone, is geographical; the area of sandstone with coal plants is western, that of the limestone is central, and true coal measures occur unconnected with either. The carboniferous formation, as a whole, exceeds that of any other geological group in this country, considered with reference to surface.

What is coal? It is pure vegetable matter—the product of plant-growths. And with respect to the mode by which it has been accumulated, two theories have been proposed: there is the "drift" theory, which accounts for its occurrence as the accumulations of vegetable matter brought down by mighty rivers, and deposited in lakes and sea-margins. There is something too turbulent in this theory to account for our great seams of fossil fuel.

The other theory is, that coal is the product of a vegetation which grew upon the very spots and covered the areas over which our coal-beds extend, like the peat-beds of the present day. This is the theory of M. De Luc, M. Ad. Brongniart, and Messrs. Lindley and Hutton.

In supposing that coal originated as peat, all that is meant is, that it is the product of a vegetation composed of like plants, such as could live on in association over the same spots, growing above and decaying beneath, but differing as widely in the plants which composed it from our present peat plants, as did the whole of the vegetation of that period from that of the present period. The huge stigmariæ are wholly unlike any plants which commence the peat growth now.

The succession of a coal-field may be seen in a small scale in the deposits of lakes which have had differences of level from local accidents; and with reference to extent, Ireland may be taken as an illustration of continuous masses of vegetable matter of vast thickness, covering the whole country for 50 miles, and at low levels. Depress Ireland ever so little, so that the waters of the sea should reach in in some places, and the river waters, such as those of the Shannon, should collect into lakes; and just in proportion as the water was shallow would an uniform stratum of sand, or silt, or gravel, be spread out above the peat growths.

The history of the coal fields of this and every country is that of an endless succession of such changes.

The question of the probable existence of coal measures at any given spot over the European area depends primarily on the original form of the surface of these coal growths; in other words, can we construct a map of Western Europe for the coal measure period?

The restoration of the physical features of a portion of the earth, for any given past period, is not so difficult, nor so purely speculative, as some may imagine. Every form and combination of mineral materials composing the sedimentary formations, all the forms of life they contain, serve to indicate the precise conditions under which they have been accumulated. Shingle and gravel mark marginal zones, sand zones mark lower or submarginal regions, deep sea deposits consist of mud or oaze. Thousands of persons who have never even heard of the inquiries of the geologist have doubtless argued that Blackheath, with its rounded shingle, must at some time or other have been at the sea side. Assemblages of marine shells are the evidences of former seas; land and fresh-water shells and plants, of old lakes and terrestrial conditions.

By the aid of such guides as these the form of the area of the coal measures may be defined. Commencing in the west, we have early indications of the proximity of dry land and fresh-water accumulations. The earliest carboniferous deposits contain fern-like plants in wonderful profusion and beauty; with them are "pond muscles" (*anodon*). The land here lay to the south. The depositions of the North of Ireland require the existence of a wide expanse of dry land somewhere beyond it on the north. The Wicklow mountains were part of the dry land of the coal period. In the beds of the carboniferous limestone near Dublin may be seen angular fragments of the peculiar granite of these mountains, and which must have been floated away by seaweeds from a shore line, just as happens now. Dry land connected the Wicklow mountains with those of Wales. If we pass over this interval we find evidence that the mountains of Wales were then dry land. The conditions of portions of the coal measures bordering on this region have been investigated by most competent geologists, Sir R. Murchison and Mr. Prestwich. In the Shrewsbury district are pure fresh-water limestones. Coalbrook-dale, throughout the whole accumulation of its beds, seems to have been immediately subordinate to an area of dry land. The great Yorkshire coal series, which has been so well described by Professor Phillips, is wholly lacustrine, with the exception of one intercalated band of marine limestone.

The proximity of dry land to the Edinburgh coal-field has been shown by the researches of Dr. Hilbert and Mr. L. Horner, in the fresh-water deposits of Burdie. The mountains of Cumberland were dry land, and so all those of the border counties which range from Wigtonshire to Berwick. All the mountains of the western highlands of Scotland, an area extending north beyond the Shetlands, and westwards into the Atlantic, was also land surface. A vast tract lay in this (the north) direction, of which the great Scandinavian chain alone remains, and which supported the rivers which bore down the waste of granitic and crystalline rocks which enter so largely into the coal-measure sandstones of our northern districts.

Passing across into the Cotentin we find a series of coal formation, skirting the old mountain ranges of the north-west of France.

The great central granitic plateau of France is fringed with coal growths, and over the whole of its surface are innumerable small coal-fields, the lacustrine accumulations of the valleys of that region; this was an upland coal region.

The Vosges mountains have been raised over a surface which was dry land, and was connected with the Schwartzwald, the Odenwald, and the Spessart, and a great tract extending north and east, whence came down that curious assemblage of terrestrial forms which has been met with in the great fluviatile and lacustrine deposits of the Saarbruch coal basin. Such is the form of the area which contains the great coal formations of western Europe.

The island which is represented in the interior of that great basin is not imaginary* evidence of direction and extent of southern coast line from shingle bed of Burnot. The extension of a band of shingle from beyond Eupen to the Boulonnais marks the direction of an old coast line which lay to the north of it. It was from this mass of land that the terrestrial vegetation, and the fresh-water shells so abundant in the Liege coal measures, were derived.

The whole area, as here described, may be compared, as to its physical characters, with large level tracts which lie west of the Blue mountains in Australia, into which the Lachlan, the Darling, the Murrumbidgee, and the Murray, discharge.

Between the close of the coal growths and the period of the formation which next succeeded, the surface of the whole of the area which has been sketched out was disturbed and broken up. Some of the lines, like that of our Pennine Chain, conform to those masses of terrestrial surface which tended in that direction; *and a very remarkable line is one which has a general east and west direction across the European area.* This line also conforms to the direction of old land which was to the north and south of it, and comprises the whole of the interval between the coal-growth surfaces of the Saarbruch districts, and those of Belgium.

The section along the Meuse affords good illustrations of the character of this band of disturbed strata. In this section the upper beds of the coal measures occupy the deep troughs; the older parts of the Palæozoic series appear in the ridges. Such is the character of the great Liege, Namur, Mons, Valenciennes coal band throughout.

The line which passes along the south of this coal band was a *boundary line for the oolitic formations, and for the earliest accumulations of the cretaceous period*; this is particularly well seen in the Boulonnais.

The question as to the probability of coal in this (south-east) part of England, depends on the relation between the physical configuration of the present surface as compared with this older surface.

The character of the axis or ridge of Artois, with its valleys of elevation, was described as a continuation of the line of disturbance along the south of the Mons coal band in the east, and as coinciding with the north escarpment of the Boulonnais on the west. The Boulonnais is physically a portion of the great elliptical denudation of Weald, of which the North Downs from Dover west are a continuation of the chalk range from Wissant east. This line of disturbance is continued on by the valleys of elevation of High-clere, Kings'-clere, &c., and opens out into the valley of Devizes, forming a great linear anticlinal ridge, which coincides with the axis of old red sandstone of Frome, supporting the coal-fields of Somerset on the north.

The principle on which the existence of a band of coal measures may be conjecturally placed along the south-east counties of England, is this,—that like physical features have a like significance; the precise probability of the continuity of the coal-band along our south-east area is great, and every fresh point of agreement adds strength to that probability; so that when these amount to three or four, the evidence may be deemed conclusive.

The Kentish Town artesian well passed through the white chalk and gault, a shingle brand of old sedimentary and crystalline rocks, ending on micaceous sandstones at a high angle. Here the points of agreement with the French and Belgic sections were, 1st, the absence of the oolitic series; 2nd, of the lower cretaceous strata; and 3rd, the occurrence of the tourtia or shingle brand, as in Flanders and the north of France.

The artesian well at Harwich found the chalk resting in old clay slate, with cleavage structure and micaceous sandstones; and from the presence of a Posidonia, may be referred to the culm series of the Rhenish provinces, or of Devonshire; in this instance there is a perfect agreement with the condition of surfaces which extend north from the Belgian coal-band.

By the help of these points, we can trace the arrangement of the old rocks beneath our south-east counties. The limiting boundary of the oolitic series, and of the lower green sand, lies south of London. The coal-trough conforms to the valley of the Thames and Kennet; older rocks still, such as those of the Belgian series, rise to the north, beyond which, at the distance of Harwich, the coal series is again brought in.

The existence of coal beneath Blackheath is, therefore, not so great an improbability as was once supposed; nor, in the absence of the whole series of secondary formations, from the white chalk downwards, is its depth probably very great.

---

* The reference here made is to a map which represented the physical features of western Europe at the period of the coal growth.

April 23rd, 1858.

His Grace the Duke of Northumberland, K.G., F.R.S., President, in the Chair.

Col. Henry James, R.E., F.R.S.

ON THE GEODETIC OPERATIONS OF THE ORDNANCE SURVEY.

The Geodetic operations of the survey include the triangulation and levelling, which extends over the whole United Kingdom, the measurement of arcs of meridians, and the determination of the figure, dimensions, and mean specific gravity of the earth.

The special object for which these operations are required was first described, and then the methods employed in performing them were briefly sketched.

The triangulation consists, 1st, of a *primary* series of triangles, the sides of which are some of them upwards of 100 miles in length, and the stations of which are placed on the highest mountains—such, for example, as Snowdon, in Wales, Sea Fell, in Cumberland, and Slieve Donard, in the county of Down, in Ireland; the sides of this triangle are each upwards of 100 miles long. This great triangulation extends over the United Kingdom. A series of stations are then selected to form a *secondary* triangulation, the sides of which are from 10 to 15 miles long; and, again, another series of stations are selected to form the *minor* or *tertiary* triangulation, the sides of which are about three-quarters of a mile in length; and thus the whole country is covered with a connected network of triangles, to form the basis of the detailed survey which is now in progress. Upon the accuracy with which this portion of the work is executed, mainly depends the character of the national survey for accuracy in its most important features.

The minor triangulation is that which is immediately used for the detailed survey; the field surveyors actually measure the length of each side with their chains, and cross lines are also measured within the triangles. As the length of each side is previously known, the correctness with which the surveyors perform their work is tested in the office, and accuracy insured in every part. The establishment of a general triangulation also enables the engineer to employ large numbers of surveyors at the same time, and without any fear of the work being distorted in any direction, as every object on the ground must under this arrangement be accurately represented in its true relative position to all others, however distant they may be. Thus, the houses represented on a plan of a parish in the centre of the kingdom are not only in their correct relative position to the houses in their neighbourhood, but also to every other house, whether in Caithness or Cornwall.

The levels on the plans are all given with reference to the mean tide level at Liverpool, or the line above and below which the tide rises and falls. Lines of levels from this datum have been carried through all parts of the country; and thus the levels also are in correct relation to each other, however distant the points may be which are compared.

The curious circumstance was adverted to that the levelling taken in Ireland, connecting the mean tide level at a series of stations all round the coast, seemed to establish the fact, that the plane of the mean tide level was inclined from N.W. to S.E., and was 3 ft. higher on the coast of Donegal than on the coast of Wexford.

The speaker was not able to offer any other possible explanation for this, than that of the impinging of the warm water of the Gulf Stream upon the north-west coast of Ireland, and he offered this as a mere conjecture.

A set of the Ordnance Plans as now produced were exhibited at the meeting. They consist of,—

1. Plans of *Towns*, on the $\frac{1}{500}$th scale, or 42 ft. to an in.
2. Plans of *Parishes*, on the $\frac{1}{2500}$th scale, or 25· in. to a mile; or 1 sq. in. to 1 acre.
3. Plans of *Counties*, on the scale of 6 in. to a mile.
4. Map of the *Kingdom*, on the scale of 1 in. to a mile.

All the plans which are drawn on the larger scales are reduced by photography to the smaller, and at a very trifling cost, and as compared with all former methods of reduction, with marvellous rapidity. This method of accurately reducing plans was first introduced by Col. James, and will effect a very great saving in the cost of the survey. The plans of the parishes are zincographed, but all the others are engraved on copper.

The methods employed for conducting the geodetic operations were then described.

The first consideration is the obtaining an accurate standard of length. The Ordnance standard of length is a bar of iron, on which the length of 10 ft., as derived from the old Parliamentary standard yard, was set off. But this standard yard having been destroyed in the fire which consumed the Houses of Parliament, a new standard has been constructed by a commission, of which the Astronomer Royal, and Mr. Sheepshanks and Mr. Bailey, were members. The superintendent of the survey had therefore to ascertain the length of the Ordnance standard in terms of the new standard of length; and for this purpose he had an intermediate standard constructed, on which $3\frac{1}{3}$ lengths of the standard yard were set off, and the 10 ft. thus derived compared with the original 10-ft. Ordnance standard. From the comparisons made between these we have a proof of the accuracy with which the national standard of length has been restored; the difference would not, in fact, amount to more than the 1-13th of an inch in a mile.

With the 10-ft. standard for reference, the late General Colby, who for many years so ably superintended the survey, designed his *Compensation Bars*, for the measurement of the base lines for the triangulation. General Colby, availing himself of the known unequal expansion of brass and iron, combined bars of these metals in the base measuring apparatus in such a way as to preserve the distance between two points on the tongues connecting the bars at the constant distance of 10 ft., under every change of temperature.

In the actual measurement of the bases, these bars were ranged in a perfectly straight and horizontal line; and to prevent any possible disturbance in the position of the first laid bars, they were separated by an interval of 6 in., the interval itself being measured with a double microscope, the foci of the microscopes being exactly at 6 in. apart, and their invariability secured by the bars connecting the two being made to compensate each other's expansion, in the same way that the 10-ft. bars are compensated. A central microscope between the two described serves as a pivot for reversing them, and also for the purpose of establishing fixed points on the ground, as points of reference in the re-measurements taken.

Sir John Herschel and Mr. Babbage were present when 500 ft. of the base at Lough Foyle were remeasured, and the error amounted to only a third (by estimation) of the breadth of the very finest dot which could be made with the point of a needle. We have thus an assurance of the extreme accuracy with which the two bases, one on Salisbury Plain, the other on the shores of Lough Foyle, in the north of Ireland, each about seven miles long, were measured. These base lines may, in fact, be described as air-lines drawn from the fine dot at one extremity to that at the other.

Having established an accurate base, the next operation is to establish some trigonometrical stations to form triangles with it; and then, by means of a theodolite, the centre of which is accurately adjusted over the dots at the extremities of the base, measuring the angles between the stations, the data are obtained for computing the length of the sides of the triangles. The sides of the triangles thus obtained become new bases, from which the length of the sides of other triangles are in like manner computed; and in this way the exact length of every line in the great network of the triangulation is accurately known. Of the accuracy with which the angles were taken we have, first, the proof by the summation of the angles in each triangle; and, secondly, the proof arising from a comparison of the computed length of one base as derived from the angular measurements, and the actual length from the linear measurements.

The difference between the computed length of the Lough Foyle base, through the triangles extending from it to Salisbury Plain, a distance of 360 miles, and the actual measured length, was 5 in.

But as this error could not be attributed to one base rather than the other, a *mean base* was established by a correction to each in the proportion of the square roots of their lengths, so that, computing from the mean base, the measured bases have apparent differences of + or — $2\frac{1}{2}$ in.

Three other bases were measured with Ramsden's 100 ft. steel chains—one on Hounslow Heath, another at Misterton Car, near Doncaster, and the third at Belhelvie, near Aberdeen; and the measured lengths of these bases differed in no instance 3 in. from the lengths as computed from the mean base.

The observed angles have also been so corrected as to render the triangulation consistent in every part; and the result is, that taking any side of any triangle as a base, and computing in any way through the triangulation, the same length will be reproduced. The triangulation may, therefore, be said to be perfect in every respect.

The latitudes of thirty-two of the principal stations were observed with Ramsden's great zenith sector, which was afterwards burnt in the great fire at the Tower, and with Airy's zenith sector, which was made expressly for the survey.

If the figure of the earth be first supposed to be a sphere, it is obvious that the length of every degree of latitude would be equal, and that when the length of a certain number of degrees of latitude is accurately known, we have all that is required to compute the length of the 360 degrees of a great circle of the earth, and of the length of its diameter; but if the figure of the earth is not a sphere, but a spheroid compressed at the poles, then the length of each degree, as measured towards the poles, will be unequal and continually increasing; and this is found from observation to be the actual fact. Thus, for example, the length of a degree in the parallel of Edinburgh is 100 yards longer than a degree at Southampton; and in the Shetland Islands it is 200 yards longer; and from a knowledge of the length of the several portions of arcs of meridians measured in this and other countries, the true figure and dimensions of the earth are known.

The elements of the spheroid which most nearly represent all the distances and latitudes are—

Polar diameter........	=	7899·5 miles.
Equatorial	=	7926·5 miles.
Ellipticity	=	$\frac{1}{294}$

The elements of the spheroid, given in Airy's "Figure of the Earth," are—

Polar diameter........	=	7899·1 miles.
Equatorial	=	7925·6 miles.
Ellipticity	=	$\frac{1}{299{\cdot}3}$

Our most recent determination, therefore, slightly increases the ellipticity, and we increase the equatorial diameter of the earth by about one mile.

One of the chief difficulties which is encountered in the investigation of the figure of the earth, arises from the local attraction at the stations at which the observations for latitude are taken, in consequence of the irregular distribution of the masses of matter in the mountains or hills near the stations, or the unequal density of the matter beneath the surface of the earth.

Thus, for example, when observations are taken on the north end of the hill at Dunnose, in the Isle of Wight, and also at the south end, the great mass of the hill being between the two stations, the difference of latitude is found to be greater than is due to the actual distance between the stations; and this, because the attraction of the mass of the hill has drawn the plumbline in each case towards it, and made the celestial arc greater than the geodetic.

The detailed survey of Edinburghshire having been published with the contours, or zones of equal altitude engraved on the plans, and thus furnishing accurate information as to the relief of the ground, the superintendent of the survey undertook, in 1854, to investigate the amount of the local attraction at Arthur's Seat; and this the more readily, as it would furnish the data for

computing the mean density of the earth itself. Observations for latitude were taken at the north and south ends of the mountain, and also on the summit, and the geological structure and specific gravity of the rocks composing it ascertained.

The attraction of the mountain was computed, by supposing it divided into a number of vertical prisms, and summing their separate attraction, resolved into the direction of the meridian.

The attraction of each prism is, according to the known laws of gravitation, proportioned to the mass, and inversely proportioned to the square of its distance; similarly, the attraction of the earth is in proportion to its mass, and inversely as the square of the distance from the centre, the ratio of these attractions is equal to the tangent of the angle of deflection. This will be obvious from the inspection of a diagram on which the attraction of the earth is represented by a vertical line, and the attraction of the mountain by a short line drawn at right angles to it, showing the extent to which the plumb line is deflected or drawn towards the mountain.

Then, if the mountain be assumed to be of the same specific gravity as the earth, the computed deflection at the

South end .... = 4·2 in.
North end .... = 3·8 in.

Or the whole disturbance .... = 8·0 in.

but the observed sum of the deflections, that is, the excess of the celestial arc above the geodetic arc, was found to be only 4·07, or little more than half what it would have been had the earth and mountain been of the same specific gravity; and consequently the earth must be of nearly double the specific gravity of the mountain.

The specific gravity of the mountain was ascertained to be 2·75, and therefore as 4·07 : 8·0 : : 2·75 = 5·45, the mean density of the earth; by employing the full number of decimals, we have 5·316 as the mean density of the earth. From similar observations at Schehallien Mountain, Hutton derived the mean density = 5·0 From experiments on the attraction of balls,

Cavendish obtained .... 5·44
Baily obtained .... 5·67
Reich obtained .... 5·44

The Astronomer-Royal, from experiments with pendulums on the surface of the earth, and at a great depth, obtained 6·55.

Col. James concluded his address by saying, "I have endeavoured to give what may be called a mere outline sketch of the geodetic operations of the survey. A full account of all these operations, and of the very intricate and laborious computations which have been made, has just been published. This account has been drawn up by Capt. Alexander Clark, R.E., who is employed with me on the survey, and I must refer all those who desire to have more precise information on these subjects to it.

"But I trust it will be understood, from what I have said, how necessary and important these operations are for the execution of a survey with that perfect accuracy which the nation has a right to expect from the officers entrusted with its execution; and that we have, at the same time, contributed data for determining the exact figure, dimensions, and specific gravity of the earth, which form the only units of measure for estimating the distances, the size, and the specific gravity, of all the heavenly bodies which surround us."

[The standard of length, and the compensation-bars used in the measurement of the bases, were exhibited in the lecture-room and described, and a series of diagrams were referred to in the course of the lecture.]

ON OIL MILL MACHINERY.

By Alexander Samuelson, Mem. Inst. M.E.

Read at the Meeting of the Institution of Mechanical Engineers, at Birmingham, 28th January, 1858.

Joseph Whitworth, Esq., President, in the Chair.

(Illustrated by Plate cxxv.)

Before considering the comparative advantages of the several appliances now used for the purpose of expressing oil from seeds or nuts, forming the particular subject of the present Paper, it may be interesting to refer briefly to the methods previously adopted before the present high state of perfection in the manufacture of machinery had been arrived at.

The means adopted for extracting oil in the last century by the natives of Ceylon, where cocoa nuts and other seeds abound, were of the most primitive description; the apparatus, as illustrated in Fig. 1, consisting simply of a few poles stuck into the ground, supporting two parallel horizontal bars, A A, between which was placed a bag, B, containing the seed or pulp of the cocoa nut from which the oil was to be expressed; a lever, C, was then brought to bear against one or both of the horizontal bars, for the purpose of bringing them together, and thereby causing the required pressure upon the seed. This rude apparatus was one of the most approved oil mills of that period. The pestle and mortar, as shown in Fig. 2, was also used for the same purpose; and from the nature of these appliances the process was necessarily exceedingly slow and inefficient. An improvement upon this apparatus is shown in Fig. 3. It is the invention of Mr. Hebert, whose object was to construct what he considered a powerful and effective machine, combining simplicity and cheapness with economy of labour. It consisted of an upright post, A, fixed firmly into the ground—the stump of a tree being often used—upon the lower and upper ends of which were projecting pieces, the upper one forming the joint of the long horizontal lever B, and the lower one the joint of the short vertical lever C, at the top of which was fixed a roller bearing against the underside of the horizontal lever B, for the purpose of diminishing the friction when the pressure was exerted upon the seed. The fixed upright post, A, and the vertical lever, C, in this instance formed the compressing portion of the machine. The pressure was obtained by the weight of a man suspended from the end of the horizontal lever, B. A double machine was also constructed upon the same principle, as shown in Fig. 4, the pressure being obtained either by weights, or by a bucket full of water, which was made self-acting, in so far that as soon as the bucket touched the ground a valve was opened, and the water escaped, thereby relieving the seed from any further pressure. The advantage of the double machine was, that it could be made portable and be moved about at pleasure, one-half of the press counterbalancing the other when both sides were in action, whereby it was rendered independent of the ground. Another appliance, of a similar description, is shown in Fig. 5, the only difference being, that in this instance there was only one lever, B, and the seed bags, instead of being placed vertically, were placed horizontally in a box, C, upon the loose head of which the action of the lever was brought to bear by the same means of animate or inanimate weights. There is also another press deserving of notice, which is shown in Fig. 6. The pressure is here gained by levers and weights, B, as in most of the foregoing examples, but with this modification, that cams, C, and wedges, D, are introduced. There is also a modification of this combined lever and cam machine, as shown in Fig. 7, in a press invented by Mr. John Hall, of Dartford, where the pressure is applied at the end of the levers, B, by means of the steam cylinder, A. This apparatus is double, consisting of two pairs of boxes, the cams being placed opposite to each other, so that the operations of compressing the seed and refilling the bags may be carried on simultaneously.

The lever presses having thus been briefly examined, the more approved and modern presses for extracting oil have now to be considered. These are three in number:—the Dutch, or Stamper Press, which was invented in Holland; the Screw Press, and the Hydraulic Press, both of which were invented in this country.

Before considering the comparative merits of these three presses, it will be advantageous to refer generally to the course of operations to be performed previous to the compression of the seed, which is the last of five operations that it has to undergo.

The first operation consists in passing the seed through a flat screen or shaker, which is kept in a constant state of agitation.

In the second operation, the seed is passed through a pair of crushing rollers, which have the effect of bruising or crushing it. A pair of these rollers, of the most improved form, is shown in Figs. 9 and 10. Fig. 9 is a transverse section, and Fig. 10 a plan of the rollers. The two rollers are of unequal diameters, the larger one, A, being 4 ft. diameter, and the smaller, B, 1 ft. diameter; the breadth of both being 16 in. or 14½ in. on the face. The larger roller, A, makes 56 revolutions per minute, driving the smaller one by friction. The seed is supplied through the hopper, C, by means of a small roller, D, very slightly grooved, which is made to revolve for the purpose of feeding the main rollers, being driven by a strap from the larger roller passing over a pulley outside the hopper. The amount of feed is regulated by the regulating plate and screw, E. Underneath the rollers are placed scrapers, F, kept in contact with them by weights, for the purpose of scraping off any seed adhering to the surfaces after crushing. These rollers for a long time were made of equal diameters; but it was found that they crushed the seed neither so well, nor so expeditiously, as they do in their present proportions. After the equal sized rollers were found to be inefficient, that known as the Ipswich Mill was adopted, in which the larger roller was 6 ft. diameter, and the smaller 1 ft. diameter; but experience proved that when any hard substance got between the rollers, the leverage over the journals was so great, that it caused much wear and tear upon those parts. Seed crushers have therefore, by degrees, adopted the medium-sized rollers, which are found to be exceedingly effective, and not liable to derangement. A pair of rollers, such as are shown in Figs. 9 and 10, will crush upon an average about 4½ tons of seed in eleven hours, which is sufficient for two sets of hydraulic presses.

The third operation consists in grinding the seed under a pair of edge stones, as shown in Figs. 13 and 14. Fig. 13 is a vertical section, one of the stones being removed, and Fig. 14 is a plan with one of the stones in section. Fig. 15 shows the vertical driving shaft, partly in section. The two edge stones, A A, are 7 ft. 6 in. diameter, and 16 in. thick, bevilled to 11½ in. broad on the face, weighing together about 7 tons. The vertical driving shaft, B, makes about 17 revolutions per minute. The seed is kept under the stones by means of the sweeper, D, and at the proper period is collected and swept off by a second sweeper, E, the slide or cover, F, being withdrawn for its discharge. While the grinding is being performed, the sweeper, E, is raised from the bed-plate C, by the hand-lever G, as shown by the dotted line. The edge stones, if of good quality, and the seed not impure, require to be refaced about every three years, and will last from fifteen to twenty years, according to their quality. One pair of edge stones will grind sufficient seed for two double hydraulic presses. The process of grinding lasts for about twenty-five minutes previous to the seed being transferred to the next operation.

The fourth operation consists in heating the ground seed in the heating kettle, shown in Figs. 11 and 12. Fig. 11 is a vertical section of the heating kettle, and Fig. 12 a plan. The kettle is heated by steam, and consists of two cylindrical chambers, A and B, one above the other, each of which is composed of an external casting, C, and an internal casting or inside kettle, D, with a sufficient space left between the two castings round the sides and at the bottom to allow a free circulation of the steam. The steam is admitted by the pipe, E, and the condensed water passes off at F, from the bottom of the kettle. The shaft, G, gives motion to two arms or stirrers, H H, in each chamber, revolving at the rate of thirty-six revolutions per minute, which keep the seed constantly agitated, so that every particle of it may come in contact with the heated sides and bottom of the kettle. The upper chamber, A, is covered with a sheet-iron lid, I, through which the kettle is charged. In heating the seed the upper chamber, A, is filled first, and the seed is allowed to remain in it from ten to fifteen minutes; the slide, J, is then withdrawn, and the seed falls through the opening, K, into the lower chamber, B, where it remains until it is required to be taken to the press; the door, L, is then opened, and the whole of the seed is discharged from the chamber, B, by the action of the revolving stirrers, H. The seed falls through a funnel, M, under which is placed a bag of suitable

dimensions, to contain a sufficient quantity of seed to make a cake weighing 8 lbs., after the oil is expressed from it. Each of the chambers in the heating kettle will contain sufficient seed for charging one single press; the heating of the seed is therefore a continuous operation of first charging the upper chamber, A, and then allowing the seed to pass into the lower one, B, in which it is heated to 170° Fahr., and is then withdrawn and placed in the bags.

Another description of kettle, of a much simpler though less effective kind, is shown in Fig. 8. In this case the seed is heated on a hot hearth, A, being confined within a loose ring, B; a spindle, C, with two arms upon it revolves inside the ring, keeping the seed stirred while it is being heated. When the seed has become sufficiently heated, the spindle and stirrers are raised a sufficient height above the top of the ring by the handle, D; and the ring being loose on the hearth, the seed is drawn forward by it, and scraped into the bag, E. In this instance the seed is exposed to the atmosphere, and there is therefore a large amount of heat wasted. It is also liable to become overheated and spoiled, and upon the whole this is a more troublesome operation, as each ring holds only sufficient seed for one bag.

The bags after being filled are placed separately between what are called the hairs, which are bags made of horsehair, with an external covering of leather. The same description of bags and hairs are used whether the oil be expressed by means of the stamper, screw, or hydraulic press.

The final operation of expressing the oil is effected in the screw press, as shown in Fig. 16, by means of an ordinary square threaded screw, A, by which the bag of seed is compressed between the bottom of the box, B, and the moveable plate, C. The power is applied by means of a loose lever inserted between studs fixed in the plates, D, which are attached to the screw. The press may be made in a vertical form, and may also be made to lie horizontally, and to be worked either by hand or by power. A very large amount of pressure may be obtained by one of these presses, but the wear and tear and derangement are excessive, and there are few screw presses in existence at the present day giving a correct idea of the exact proportions or pressure applied.

The stamper press is shown in Fig. 17. It consists of a long rectangular cast-iron box, A, open at the top, at each end of which there are two plates, between which one bag of seed, B, is placed, yielding a cake weighing 9 lbs.; next to one of the inner plates is placed a filling up piece, then an inverted wedge, C, then another filling up piece, after which is introduced the vertical driving-wedge, D, and lastly another filling up piece is inserted between the driving-wedge and the other inner plate. As soon as the bags, B, have been placed vertically in the press-box in the usual manner, a stamper, E, made of wood, about 16 ft. long and 8 in. square, with a fall of about 22 in. in the final stroke, is allowed to fall at the rate of 15 strokes per minute for a period of about six minutes upon the head of the driving-wedge, D, which is sufficient to drive it down level with the top of the press-box, A, the stamper being worked by two cams or wypers on the revolving shaft, F. Side by side with the stamper, E, is a second stamper, G, immediately above the inverted wedge, C, which is held suspended at a fixed point by means of the lever, H, while the first stamper, E, is in action; but as soon as it is time to remove the bags the stamper, E, is raised by means of the lever, H, above the point at which the cams come into contact with it; and by the same means the other stamper, G, which was previously suspended, is allowed to fall upon the inverted wedge, E, driving it downwards, and thereby relieving the working wedge, D, so that the attendant may remove the bags and repeat the operation. A press like this will not do more than about 12 cwt. of cake per day.

The last mode of expressing the oil is by means of the hydraulic press, which may fairly be said to be the most approved system that has yet been adopted. This press is simply Bramah's press arranged specially for the purpose of expressing oil, and appears to have been in use for this work more or less for 30 years, although the earlier presses were very defective as compared with those in use at the present time. One of the first hydraulic presses that was constructed is shown in Fig. 18. In this arrangement only one press and one set of small pumps was introduced. The box, A, which receives the seed, is in one piece, and runs upon a small tramway, for the purpose of withdrawing it from the press to remove the cake and replenish the bags; each time therefore that the press is put into operation the entire box has to be withdrawn in order to empty and replenish it; and it has then to be replaced upon the ram, B, after which it is lifted bodily upwards, so as to bring it into contact with the press head, C, which fits accurately in the press-box, A, and acts as the point of resistance when the pressure is upon the ram. The constant withdrawal and lifting of this heavy box must evidently be a great loss of power and time. Presses of this description have been at work at Deptford until within the last few weeks, but they have now been removed and replaced by those known as Blundell's presses, which are now universally admitted to be the most efficient appliance for the purpose.

Blundell's double hydraulic press is shown in Fig. 19, and in detail in Figs. 20, 21, and 22. Fig. 20 shows a vertical section of the press, with an elevation of the pumps; Fig. 21 is a sectional plan of the press, with a plan of the pumps; and Fig. 22 is a longitudinal section through the press-boxes. The double hydraulic press consists of two distinct presses, A and B, Fig. 19, supplied by two pumps, C and D, one of which, C, is $2\frac{1}{2}$ in. diameter, and the other, D, 1 in. diameter, both connected to each distinct press cylinder by means of hydraulic tubing, E. The stroke of each pump is 5 in., and they make thirty-six strokes per minute; the larger pump, C, is weighted to 740 lbs. per square inch pressure, and the smaller, D, to 5,540 lbs. per square in. The diameter of the press-rams, F, Fig. 20, is 12 in., and the stroke 10 in. Each press is fitted with four boxes, G G, and receives four bags of seed in the spaces, H H, producing in all a weight of 64 lbs. of cake at each operation. After the heated seed has been removed from the heating kettle and placed in the canvas and hair bags, which is done as speedily as possible, so that it may retain its heat, the attendant first fills one press, A, and opens the communication between the large pump, C, and the charged press, A, by means of the valves, I, which causes the ram to rise until there is a total pressure of about 40 tons exerted on the press; the safety-valve connected with the large pump, C, then rises and is kept open by means of a small spring catch. Whilst this operation is going on in the first press, A, the second press is being filled in the same manner; the communication is then opened between the large pump, C, and the press, B, by means of the valves, I, the safety-valve of the pump, C, having been replaced in its original position; the ram of the second press, B, is then raised to a corresponding position with that of the first press, A, when the safety-valve of the pump, C, rises a second time. The communication between the large pump, C, and the press, B, is then closed, and at the same time a communication is opened by the valves, I, between the small pump, D, and the presses; and the extreme pressure exerted by the small pump, D, amounting to about 300 tons, is allowed to remain upon the rams for about seven minutes from the time that they were first brought into action; this, together with three minutes allowed for emptying and charging the press, is the full time required for expressing the oil in the most effectual manner. The oil in leaving the seed passes through the canvas bag, and then through the hair bag, where it finds a free exit at the edges; thence it runs into a channel or groove, K, which passes round the upper portion of each press-box, G; a communication is made from one box to another by means of piping, L, so that the oil passes from the upper boxes through the lower ones, and thence into the cistern, which is called the spell tank, being just large enough to hold the produce of one day's work. These presses are not worked with water; it has been found that oil which is not of a glutinous description works much better, and keeps both the pumps and presses in a better condition. It is scarcely possible, if the presses are properly constructed, that they should meet with any accident; this can only occur where, through carelessness, an excessive weight is placed upon the safety-valve levers, or where the valves themselves are allowed to stick through want of cleanliness, from the attendant not taking care to remove the oil which sometimes becomes clotted round the valves. Each of these presses is capable of producing 36 cwt. of cake per day of eleven hours, and the yield of oil may be taken at about 14 cwt. in the same time; this of course depends much upon the nature of the seed. The cake is trimmed or pared at the edges by means of a small paring knife, after which it is put into a kind of rack to allow it to cool and dry, so that it will not become mouldy when stacked. The oil is pumped from the spell tanks into larger tanks, capable of holding from 25 to 100 tons, where it is allowed to remain for some time for the purpose of settling, previous to being brought to the market in that condition, or to undergoing various other processes, such as refining, &c.

The question has now to be considered of the relative merits of the three descriptions of presses of the most recent date.

For all practical purposes the screw press is quite unfit to be compared with either the stamper or the hydraulic press, from the objection that it is constantly liable to break-downs when driven by steam power, there being no portion of the machinery that will yield if the pressure is not relieved in time either by the attendant or by some self-acting contrivance, the best of which are very uncertain in their action; whereas, in the case of the stamper press, the stamper being loose and independent of the press-box, any risk of breakage by an overstrain or excess of pressure is in a great measure avoided by the stamper recoiling and leaving the wedge at a fixed point after it is tightly driven home. It might be thought that, since a greater pressure can certainly be obtained by the screw than by the stamper press towards the latter portion of the operation, and from the fact of there being nothing which will yield except the seed, the screw press must consequently express the oil more speedily and effectually: but this is not the case, for the stamper is made of sufficient weight to enable it to extract all the oil, although at a slower rate; and the regularity in its working, owing to its freedom from break-downs, enables it to crush on an average quite as much, if not more, seed in a given time than the screw press. If the loss of profit during repairs, and the cost of the repairs themselves, be taken into consideration, there can be no doubt that the stamper press is far superior to the screw, notwithstanding that the former seems at first but a primitive appliance as compared with the latter. In this particular of freedom from break-downs, however, the hydraulic press is far superior to either of the other two; for the safety valves of the pumps rise at the precise moment when the requisite force is obtained; and the force can be increased far beyond that which can be obtained by either the screw or stamper. Independently however of this latter advantage, the hydraulic press combines in itself the good qualities of both the other presses, without their accompanying disadvantages. For in the hydraulic press there is a certain accumulation of force which is maintained for a sufficient length of time without any possibility of injury occurring to the machinery: whereas, as has already been observed, the accumulation of force in the screw is liable to be increased beyond a safe point, leading to the destruction of the apparatus; and in the stamper the very safeguard which it possesses in its tendency to recoil leads to a loss of time whilst it is performing its duty. Taking into consideration, therefore, the freedom from derangement of the hydraulic press as compared with the screw, and its continuous action without loss of time or power as compared with the stamper, it certainly ranks higher than either as a mechanical appliance for the required purpose. The wear and tear in the working parts of the screw, as compared with that in the other presses, has been quite sufficient to drive it from the field, and to leave the only practical question between the stamper and the hydraulic press. In corroboration of this point, independently of the fact that the screw is almost entirely abandoned in this country, it was clearly proved to be inferior to the other two by a series of careful experiments made some years ago at considerable expense at the Chateau d'Eu, where an oil mill was erected by the late French King, Louis Philippe, and worked by the three different methods under consideration. This mill came under the writer's personal inspection about two years ago, when he had occasion to visit it with Mr. Graham, of London, a practical seed crusher, for whom he has since erected the machinery in a mill near London, which is represented by the model now exhibited. The hydraulic press in the French mill was an inferior piece of workmanship: had it been similar to those used in England, the comparison would have been even more unfavourable to the screw press.

Next, as to the merits of the stamper as compared with the hydraulic press,

the experience of the practical crushers in this country will give the most correct guide; and the writer has ascertained from Mr. Blundell, of Messrs. Blundell, Spence and Co., of Hull, to whom the present state of perfection of oil mills is so greatly owing, that the cost of labour with the hydraulic press is 7d. per quarter of seed crushed, whereas with the stamper it is 8d. for the same amount of work done, being a saving of about $12\frac{1}{2}$ per cent. with the hydraulic press. Moreover, the wear and tear in the stamper mill, not only in the machinery itself but also in the building, is twice as great as in the hydraulic mill, owing to the incessant shocks caused by the falling stamper, which are transmitted to the building and its foundation; there is also a constant destruction of wedges going on, which is altogether avoided in the hydraulic press, although against this there is in the hydraulic press the expense of the rams and pump packings. And thirdly, as a practical proof, which is after all the best, we find that the mills in Hull which were originally worked by stampers are now completely remodelled; and there are 94 hydraulic presses in use and only 15 stampers, the latter being equivalent in their productive powers to only about 5 hydraulic presses; the stampers consequently now form only about five per cent. of the machinery in use there. The writer can also state that Messrs. Earles and Carter, of Liverpool, the most extensive seed crushers in the country, had nothing but stampers in use in 1851, at which period one double hydraulic press was fixed by his firm in their establishment. This was tested very severely against the stamper, and met with unfair usage for a period of six months; for the men soon finding that such a press would produce more than twice as much as the stamper, feared that, unless the advantages of the hydraulic press enabled the employer to increase his manufacture, it would throw out of employment one-half the number of press hands then employed. Like most uneducated men however, they omitted to take into consideration that the facility of production would necessarily increase the sale of the article manufactured, and that if they were thrown out of one branch, they would find employment in another.

(To be continued.)

REVIEWS.

A Manual of Applied Mechanics. By W. J. Macquorn Rankine, LL.D., &c. R. Griffin and Co., London and Glasgow. Crown 8vo, pp. 640.

Dr. Rankine has produced a work which adds additional lustre to an already brilliant reputation acquired in connection with scientific research, and the development and teaching of practical science. Book-making is not the field in which Dr. Rankine has heretofore laboured. In the workshop and the laboratory, in practically carrying out mechanical and constructive engineering works, in the pursuit of knowledge everywhere, and in the exposition of such knowledge, he has attained high fame and just celebrity, not only in the class-room, but in the meetings and proceedings of the learned societies, and is a *savant* in the councils of the *savans* of this country; possessing a mind so thoroughly well stored with, not simply speculative and abstract science or theory, but with the most useful of all knowledge for the advancement of practical science, for which we as a nation are so justly celebrated, namely, *sound practical appliable science*, available for practical men and for practical purposes; also possessing in the highest degree the facility of imparting that knowledge both orally and written, as we can testify. The present work, however, presents no ordinary evidence of the latter power.

Having said thus much of the Author, we now proceed to his book. The volume before us forms one of a valuable series of works published by Messrs. Griffin and Co. as a "Cabinet Edition of the Encyclopædia Metropolitana," and possesses the charm, common to the series, of having its contents systematically arranged and thoroughly displayed, the want of which in most of our handbooks and works of reference is felt to be a great fault, and a source of trouble to the student.

The object of the book is to set forth, in a compact form, those parts of the science of mechanics which are practically applicable to structures and machines. One peculiar branch of mechanics, not usually found in elementary treatises, is explained in the work, namely, that which relates to the *equilibrium of stress*, or internal pressure, at a point in a solid mass, and to the general theory of the elasticity of solids—a subject which, as the Author well remarks, is the basis of a sound knowledge of the principles of the stability of earth, and of the strength and stiffness of materials; but the only elementary treatise on which that has hitherto been published is that of M. Lamé, entitled "Leçons sur la Théorie Mathématique de l'Elasticité de Corps Solides." In treating of the "Stability of Arches," Prof. Rankine takes into account the lateral pressure of the load; the only writer who has hitherto done so, in an exact manner, being M. Yvon-Villarceaux, in the "Mémoires des Savans Etrangers;" whilst the correct laws of the "Flow of Elastic Fluids," and the true equations of the action of steam and other vapours against pistons, as deduced from the principles of Thermodynamics, by Prof. Clausius and the Author himself contemporaneously, are here for the first time stated and applied in an elementary manual.

To the methodical classification of the subjects of the treatise—a point of such high importance to the student, and so conducive to the correct understanding and ready application of the principles of any science—the Author, in redemption of the promise in his Preface, has evidently throughout the work devoted great attention. His care is exhibited in particular in having kept in view the *distinction* between the "comparison of motions" with each other, and the relations between "motions and forces"—a most indispensable distinction, which was first pointed out by Monge and Ampère.

On a future occasion we purpose entering more in detail into the merits of this work.

The Book of Ornamental Alphabets, Ancient and Modern, from the Ninth to the Nineteenth Century; with Numerals, &c. By F. Delamotte. London: E. and F. Spon, 1858.

This collection of alphabets and numerals will be found of great assistance to architects and others. It is the best collection we have ever seen, and reflects great credit upon the research and professional ability of the author.

Questions on Subjects connected with the Marine Steam-Engine and Examination Papers. By Thomas J. Main, M.A., F.R.S., Ast. S., Mathematical Professor of the Royal Naval College, Portsmouth, and Thomas Brown, Chief Engineer, R.N., attached to the Royal Naval College. London: Longman, 1857. Pp. 108.

We have here a series of practical useful arithmetical questions relating to the various portions of steam machinery, arranged in order of difficulty, as the Authors state in their Preface, "for the use of those who have not the advantages of a tutor." The appearance of some questions at the end of the second edition of the "Marine Steam-Engine" led to a suggestion to the Authors that a separate work, containing a more copious collection of examples of the same kind, would be highly useful to students: hence the present publication.

The reputation of the Authors is well established by their previous works, the really practical value of which has been so largely appreciated by those for whom they have written; but if anything was needed to enhance their reputation as writers of thoroughly serviceable and practically useful hand books, the present work undoubtedly entitles them to it. We advise every student in steam to adopt Messrs. Main and Brown's book, to study carefully the course of questions in the first part, and prepare himself upon the examination papers given in the second division of their work; and if he well and faithfully follows our advice, we will guarantee that he will pass his examination triumphantly.

An Elementary Treatise on Iron Metallurgy up to the Manufacture of Puddled Bars. 8vo. pp. 528. By Samuel Baldwyn Rogers, of Nant-y-glo, Monmouthshire. London: Simpkin and Co., and "Mining Journal," Office. 1857.

Although Mr. Rogers' work on "Iron Metallurgy" is dated 1857, we are informed by the publisher, by way of apology, that the typographic portion was completed at the end of last year, but in consequence of the plates and other illustrations not being completed, the volume was not issued until last month.

The Author is known for his devotion to the subject upon which he has undertaken to write. No man better understands practically the manufacture of iron, metallurgically speaking, than the Author, and in the volume before us he has treated the subject ably and in a philosophical spirit.

We suggest to such of our readers as are interested in the subject—and who is not?—to carefully peruse the work, which will amply repay them for the trouble. We consider that Mr. Rogers' works, following, as it does, so immediately after Truran's, posts the subject of iron manufacture and the philosophy of iron-making up to the latest date.

An Elementary Treatise on the Combustion of Coal and the Prevention of Smoke, chemically and practically considered. By C. Wye Williams, A. Inst. C.E. 1 vol. 8vo, pp. 252. London: Weale, 1858.

Mr. C. W. Williams has reproduced his well-known work, "The Combustion of Coal," &c., in a new form, and added, as an appendix, extracts from the second report to the Steam Coal Colliers' Association, by Longridge, Armstrong, and Richardson.

In its present shape it is a useful addition to Weale's valuable series of rudimentary treatises, and for which it was particularly suited.

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*—Ed.]

To the Editor of The Artizan.

Sir,—"No two men think alike who think at all" is the aphorism of a distinguished psychological writer. How, then, are we to account for the letter of a "Looker On?" It presents the phenomenon of two men possessing precisely the same mental idiosyncrasy. The peculiar phraseology—the striking disregard of the rules of syntax—the morbid feeling of impotent ambition—the confused conception of principles—are all familiar to us: *they* are *old;* but the *signature* appended to them is *new.* How is this? Has a metempsychosis taken place, or a vulgar trick been played? The ostrich hides its head in a hedge and imagines its body concealed—silly bird! But there are other bipeds who have recourse to artifices which are equally silly: "*qui facit per alios, facit per se.*" Some one can translate this maxim for "Looker On;" he can apply it himself. He deems me so stupid that I do not understand "the basis of the cube theory," and so remiss that I have not defined my own. But he should be lenient; even he could not do this by himself: he tells us that, *with the assistance of another,* he has accomplished the feat, and the "cube theory" *versus* the "square theory" are, by their conjoint effort, thus expounded: "The cube theorists, I may add the mechanical world, assert that the mechanical effect of force (foot-pounds) is *unlimited* as expressed in the definition of power, viz., the product of the force and space passed over; while we (Messrs. "Looker On and Co.") assert it to be a constant quantity, or the product of the retarding pressure and velocity." Really, the "cube theorists" out of the mechanical world, the mechanical world added to them, and myself, as a sort of erratic atom—whether in the mechanical world or out of it I know not—are but merely dazzled with this flash of thought. *Certes,* if this is what we have been arguing about, we did not know it. But I forbear: some men would rather be flogged than forgotten. Depend upon it, Sir, there is but one brain in existence that could have generated this prodigy: "Looker On" has merely performed an obstetric part in its production.

Notwithstanding the valedictory character of my last notice of Mr. Mansel, he tempts me to make another appeal to him. He again usurps the office of Censor. My style—my mode of argument—my wit—are not to his taste. He thinks there should not be a hint about Greek comedy in a scientific discussion, but seasons it himself (of course more appropriately) with a spice of comic Spanish romance. I cannot honestly retort the charge of wit, but I declare most conscientiously that he has spared no effort to make himself as disagreeable as possible without it. Tastes differ. I like levity better than malignity,

smiles better than sneers, and ridicule better than rancour. The cube theory is *per se* ludicrous enough, but when with the arrogance of Mr. Mansel's first paper an *outré* conception of *vis viva* was produced as a proof of its validity, it was not easy to restrain risibility. His reiterated flings at my ignorance of arithmetic, of mechanical principles, of everything, "pass by me as the idle wind, which I regard not." I have, however, convicted him both of arithmetical and algebraic blunders, while I have been lucky enough on my part to avoid such mistakes. These are trifles. But Mr. Mansel has an odious and unscrupulous habit of imputing mendacity and fraud. I should be worse than contemptible, I should be criminal, if his charges of this kind against me were not untrue. An utterly unfounded charge of misrepresentation is to be found in almost every paragraph he pens. But my main object in now appealing to him is to set myself right with regard to "Earnshaw's Dynamics" and "Atwood upon Rectilinear Motion." In the one case he has charged me with forging a passage; in the other with misrepresentation too gross to be ascribed to "ignorance." I have no objection to his pelting me with *snowballs*, and can join in such sport with a hearty zest, but these malevolent missiles are *stones*.

Previous to disposing of these aspersions, I will concisely state that his present remarks upon *vis viva* exemplify his quotation from Cervantes "*peor es meneallo*," the "more he moves the more he muddles;" he will pardon this free translation, but he should have given us a better. He has been poring over his books, instead of relying upon his reasoning powers, and consequently we have "confusion worse confounded"—a column of THE ARTIZAN devoted to inverted commas and repellent scraps from different authors. I leave the *disjecta membra* to your readers, and if they can convert them into a symmetrical argument in favour of the cube theory, their minds must be infinitely more *kaleidoscopic* than mine.

Mr. Mansel seems to demur to my statement that "weight, motion, and time" are the elements of work, yet it is but a paraphrase of Watt's definition of a unit of steam power, "33,000 lbs. lifted 1 ft. high in a minute." No mechanician dissents from this. I can hardly persuade myself that my opponent would disregard the *time*, and declare that 33,000 lbs. lifted 1 ft. high *in any time* is a H.P., although some of his remarks would fully justify me in doing so. He states that "if I had understood the third law of motion, as illustrated by Atwood's celebrated machine, I should have seen that the inertia of a fluid, acted upon by a plane drawn through it, is in proportion to the square of velocity." In this his mystified state of mind is apparent, for Atwood's machine demonstrated (as I shall presently more fully explain) that inertia and velocity must, with a constant force, vary in a simple inverse ratio. And Mr. Mansel himself immediately afterwards asks, "must it be again pointed out that a plane with a velocity = 2 *in any small time*, encounters twice the weight of water that is encountered in *the same small time* by a similar plane moving with a velocity = 1?" I answer, this was quite unnecessary. Cannot Mr. Mansel perceive that if by "*any small time*," and by the "*same small time*," he means a finite portion of time (and he must mean this, or the expressions are meaningless), then, if inertia is proportional to the weight moved, which it is—and if, as he says, a twofold velocity causes a double weight of fluid to be moved in the same time—the only rational conclusion is, that as "twofold" and "double" are synonyms, *inertia varies as velocity*, and not as its square? The power expended upon the quantity of inertia in the "same small time" is another matter. Professor Robison proves that the mere force of impact of the plane against the fluid is, to use his own expression, "by all the laws of mechanics," simply as the velocity. Newton's theorem—which no one would now dare to dispute, although some misinterpret it—is, "the motions communicated to the fluid, and therefore the motions lost by the body IN EQUAL TIMES, are as the squares of the velocities." I would recommend Mr. Mansel to abstain for a short period from perplexing his mind with matters apparently beyond its grasp, and enquire whether what has been called *resistance* is not in fact *power expended* in any small time. The amount of resistance in a small time is, as he says, 4 : 1 for a double velocity. But indoctrinated as he has been by certain books, he has the vice of ignoring *time*. This is reprehensible, because it is manifest that if a pressure = 1, in a unit of time will do a definite amount of work, there must be a fraction of that unit during which a pressure = 4 will do *less*, another fraction at which it will do the same. And the ratio of work can only be determined in connection with a prescribed limit to time. Taking, then, the same finite time, when velocity = 2, the plane passes through a double space, impinges against twice as many particles as it impinges against when velocity = 1. It does so with twice the colliding force, and the proper measure of power expended must be (putting f = force, v = velocity, t = time) $f\,v\,t$; but as f and v vary alike, $f\,v = v^2$, and consequently $v^2 t$ is the measure of the power expended. But if this is true of a millionth part of a second, it is also true of an hour; once make t the symbol of a finite quantity, and it may represent a second or a century.

I will here venture to throw out a suggestion for candid and indulgent consideration. It seems that engineers have puzzled themselves and us with an anomaly. *In the steam-engine they very properly ascertain* RESISTANCE, *but call it* PRESSURE: *in fluid resistance they ascertain* PRESSURE, *and call it* RESISTANCE. If the indicator shows a quadrupled "*pressure*," we know that we are counteracting the force of gravity, lifting weight, overcoming "*resistance*" of a fourfold amount. On the other hand, we see in fluid resistance a fourfold pressure produce a double motion, and to designate this a fourfold "resistance" is very much like reckoning the power of a steam-engine by the pressure in the boiler, and disregarding the size of cylinder and length of stroke. We know a fourfold expenditure of steam will not overcome a fourfold resistance through a doubled space; and that if we merely vary pressure as we vary resistance, that we shall get no increase in our number of strokes per minute.

I now have to deal with Mr. Mansel's charges of fraud. First, let us see what the truth is with regard to "Earnshaw's Dynamics." I quoted from the work—an 8vo volume of 185 pp., written, as its preface states, at Cambridge, "principally for the use of students in the university"—the following passage, which is at page 79, art. 139, cap. 7—"The principle of *vis viva* is not true, if any of the bodies move in a resisting medium." Cap. 10 of the work is "On the motion of a particle of matter in a resisting medium." In this chapter it states that the "resistance to a given body ∝ (density). (velocity)² nearly." The subject is profoundly discussed through twenty pages: there is not a sentence in the whole chapter which does not accord with my views; but VIS VIVA *is not applied to a single case, nor are the words once used through the whole chapter.* Mr. Mansel replied *by charging me with forging the extracted passage!* In your April number, p. 101, you quoted from the same work the whole of the article on the "Conservation of *Vis Viva*," and reproduced the very passage in question. Mr. Mansel makes no apology, but now admits that I quoted the passage, and, practising upon the gullibility of your readers, pretends that the quotation is from a "superseded *horn book*" by "Earnshaw." Your extract from the work will show that it is a recondite university text-book. The folly of Mr. Mansel is as striking as his injustice: does he suppose that Earnshaw would produce an error in a primer, that he might subsequently expose it in a more abstruse and elaborate publication? Talk of "nonsense," indeed! This, if you please, is unmitigated nonsense. I, considering fraud out of the question with regard to him, concluded that we had different editions of the same book; it turns out that my edition was published in 1832, his in 1839. In your notice of the work it is stated that the work is scarce. This, with his usual recklessness of assertion, he denies. But my bookseller has tried his utmost to procure the 1839 edition for me; he reports that it is out of print, and that he is unable to get it.

Mr. Mansel says, "'G. J. Y.' took the trifling liberty of assuming that Cambridge mechanicians accepted a proposition because it happened to be found in a superseded horn book." "Cambridge mechanicians!" Who are they? I take the liberty of telling Mr. Mansel that such egregious folly is discreditable to him.

We will now see whether I have misstated or misunderstood Atwood. I said, "If Mr. Mansel will consult 'Atwood on Rectilinear Motion,' he will find demonstrated, from experiments with the celebrated machine, illustrated with profound mathematical skill, that if the force of gravity be brought to bear upon the inertia of a mass of matter by the instrumentality of any falling weight, *then the* INERTIA overcome is precisely in the inverse ratio of the velocity, and not of the square of the velocity." Mr. Mansel, in his flippant running commentary, questions this. It is evident that he really knows no more of Atwood than he does of M. Comte, however glibly he may speak of either. "Applied mechanics" are not to be found in Atwood's work, but no author whatever has more clearly or conclusively demonstrated mechanical principles. If Mr. Mansel would renounce the transcendental, and study the matter-of-fact philosophy of this author, he would not have to ask, "Does his—Atwood's—machine not teach him that the force of gravity upon a lb. falling at 10 ft. velocity is the same as when it falls at 20 ft. velocity?" and then stultify himself by arguing that this constant and limited amount of *force* is capable of doing, in the same time, a varying and unlimited amount of *work*. Yes, I confess the machine does teach that the force of *gravity* upon a falling weight is the same, whether its velocity be 10 ft. or 20 ft. per second; but I lament that Mr. Mansel has not a machine, either mental or mechanical, that will teach him that a foot of work in the one case is equal to 2 ft. of work in the other. His obtuseness of perception upon this point diminishes my interest in our conflict; it puts one on his mettle when his opponent is somewhat "cunning of fence."

Atwood's views admit of further development, so as to be illustrative of the topic under discussion, and beneficial to the readers of THE ARTIZAN. Plagiarism has preyed upon this author, but Mr. Baker, in his excellent treatise on Dynamics, evinces a due appreciation of his merits, and honourably states from whom he derived his data. Mr. Baker first describes "Atwood's machine," and then goes on to state: "Two equal weights, P P, are placed in two equal boxes, connected with a string passing over the pulley; these weights will exactly balance each other. Now let another weight, p, be added to either of them, and it will then be found that the velocity generated in a given time is always proportional to $\frac{p}{2\,P + p}$; and if p be constant, the velocity is inversely as $2\,P + p$, which is the whole mass or weight moved." And he adds, "This establishes the truth of Newton's third law of motion most satisfactorily." Contrast this with Mr. Mansel's "simplest" application of "*vis viva* in its simplest form"—his notion that an amount of force must be expended upon a particle to give it any velocity in proportion to the square of that velocity—and judge of his capability for deciding the question before us.

Mr. Baker proceeds to show that, when two weights (Fig. 1), P and Q, hang over

Fig. 1.

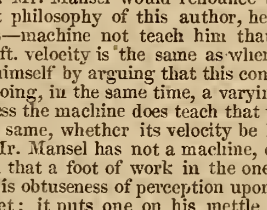
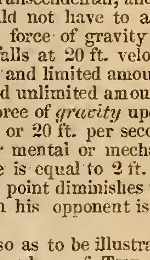


Fig. 2.



a pulley, supposing the pulley and cord to be without weight and friction, the

formula $f = \frac{P - Q}{P + Q} g$ = gravitating force; and when P hangs vertically, and Q is on a horizontal plane, without friction (Fig 2), then it is $f = \frac{P}{P + Q} g$. In the first case P — Q is the moving force, and P + Q the mass moved. Let P = 97, Q = 96, and let the time be 10 seconds; then $f = \frac{97 - 96}{97 + 96} g = \frac{g}{193}$; and substituting this for g in the common formula, $S = \frac{1}{2} g t^2$, we have $\frac{\frac{1}{2} g t^2}{193} = \frac{193 \times 100}{193} = 100$ in. space fallen through in 10 seconds. Observe, the value of g is in inches.

With the same time, let P = 290, Q = 289. Then $f = \frac{290 - 289}{290 + 289} g = \frac{g}{579}$. Operating as before, we have $\frac{193 \times 100}{579} = 33\frac{1}{3}$ in. in 10 seconds.

Results:—
Forces ....97 — 96 = 1, and 290 — 289 = 1 ......Constant.
Space passed through in ten seconds, 100 in. and $33\frac{1}{3}$ ......3 to 1.
Inertia overcome 97 + 96 = 193, and 290 + 289 = 579 .. 1 to 3.

Or inertia is inversely as velocity.

Again, in the second case, $f = \frac{P}{P + Q} g$. Let time again be 10 seconds, and P = 1, Q = 192. Then, using the common formula, $S = \frac{1}{2} g t^2$, as before; we have $f = \frac{1}{193} g = \frac{193 \times 100}{193} = 100$ in., space which Q is drawn along the plane in ten seconds. And making Q = 578, P = 1; then $f = \frac{1}{579} g = \frac{193 \times 100}{579} = 33\frac{1}{3}$ in., as before.

Results:—
Forces.............. P = 1 and P = 1 ....Constant.
Space passed through, 100 in. and $33\frac{1}{3}$ in............3 to 1.
Inertia overcome 1 + 192 = 193, and 1 + 578 = 579 .... 1 to 3.

Thus, again, *inertia is inversely as velocity.*

Now I defy Mr. Mansel to produce any case whatever of *rectilinear motion* in which, if the force be constant, and measured as usual by gravity, the inertia overcome is not inversely proportional to the velocity, and not to its square. With central forces, or systems of bodies acting and re-acting reciprocally upon each other in free space, we have here nothing whatever to do. *These*, however, may be shown to be as strictly in accordance with Newton's third law as the above.

Even in a system of bodies the complicated actions and re-actions of which mathematicians have so admirably investigated and formulated, *work is accumulated or expended in the same time* IN THE RATIO OF THE VELOCITIES, AND NOT OF THEIR SQUARES.

$\left(\frac{w}{g}\right) v^2$ = *vis viva*, and $\frac{1}{2}\left(\frac{w}{g}\right) v^2$ = accumulated work, are but old friends with new faces.

w is the quantity of matter moved, g is the force of gravity, and $\left(\frac{w}{g}\right) v^2$ is but $\frac{v^2}{g} w$, while $\frac{1}{2}\left(\frac{w}{g}\right) v^2$ is the well worn $\frac{v^2}{2g} w$ in another shape. The very terms employed indicate Mr. Mansel's blunder in applying *vis viva* to this question. When motion is constant, *vis viva* is unvarying, and no work can be accumulated when force is expended as fast as it is produced.

To test these remarks, we may conceive of the forces of a system being resolved into two, operating in opposite directions, and represent them by two weights and a pulley. Let $g = 32$ for convenience, instead of $32\frac{1}{6}$; A and B be two weights; and disregard friction and inertia of pulley. Then if A = B, we have quiescence. If A = 10, B = 6, the accelerating force will be (10 — 6), or $\frac{4}{16} g$.

Now it is easy to show that the work accumulated in the "system" during any time is *simply as the velocity of its motion, and not as the square of that velocity*. We will try it for a second. The motion will be 4 ft., thus (10 × 4) — (6 × 4) = 16, will be the balance or accumulated work *measured by the velocity* 4, *and not by its square*. Applying the *vis viva* formula to this, the motion has commenced from rest and been 4 ft., terminal velocity is therefore 4 × 2 = 8, $w = 10 + 6 = 16$, $v = 8$, $g = 32$. Thus $\frac{1}{2}\left(\frac{w}{g}\right) v^2 = \frac{1}{2}\left(\frac{16}{32}\right) 64 = 16$, as before.

The work would go on accumulating as follows:—

During the 1st second	16
" 2nd "	48
" 3rd "	80
" 4th "	112
Total work accumulated in 4 seconds.............	256

At the end of the 1st second velocity would be......		8
" 2nd	"	16
" 3rd	"	24
" 4th	"	32

Mr. Mansel and others, who look at facts only through a mathematical medium, point to this dynamic law and say, "here is work increased from 16 to 256, and velocity increased from 8 to 32; surely the work must be as the *square of velocity*, for 16 : 256 : : 8^2 : 32^2. But these gentlemen overlook the fact that the velocity squared *is the motion per second*. The work accumulated may be the product of an indefinite number of seconds. The velocity at any instant *squared* is the measure of the work accumulated *at that instant*, but it is no measure of the constant ratio of work to velocity. The following Table will illustrate this:—

Seconds.	Work accumulated in the second.	Ratio.	Initial Velocity.	Terminal Velocity.	Average Velocity.	Ratio.
1st	16	1	0	8	4	1
2nd	48	3	8	16	12	3
3rd	80	5	16	24	20	5
4th	112	7	24	32	28	7

Here Mr. Mansel may learn that the work done is simply as the velocity, and perceive how his "foot pounds" and *vis viva* may both be saved. But in return for this benefit he is bound to admit that, if while the motion is accelerated, the work done is not as the square of velocity, it cannot possibly be so when the motion is constant. Gravitation is the constant force when falling weights are contemplated, and its action cannot be inverted. But if any constant pressure act upon a free system and force be accumulated in the system, the above is the law of its accumulation. If the pressure be suspended, accumulation ceases; if the pressure be reversed, the *precise converse of the above* takes place. The last proposition is the principle of the law of projectiles.

My time and your space will admit only of a brief reference to Atwood's views, as expressed by himself. To compare some modern authors to him is making "Tritons of minnows." I beg to assure Mr. Mansel that he was no "metaphysician," although he said little about "applied mechanics." I defy contradiction when I assert, that his great work is undeviatingly in accordance with the opinions you have permitted me to publish in The Artizan. At page 364 he states, "the experiments made on the effects of percussion on soft bodies, &c., in order to prove the truth of the measure of momentum expressed by $\frac{V^2}{v} \times \frac{Q}{g}$, were prior to the time of Bernoulli's theory, denominated *Conservatio virium vivarum* . . . . . perceiving this principle, to obtain in several instances, he too hastily concluded it to be universal, and, as is well known, by reasoning from it systematically, was led into mistakes and inconsistencies, which he chose to employ his ingenuity in defending rather than forego a preconceived theory." The very prototype of a modern *vis vivaist!* At page 371, treating upon Newton's third law of motion, he says, "in a given time the variation of velocity generated in that time will be always proportional to the accelerating force: that is, to the moving force directly, and quantity of matter inversely."

I have met with some to whom the following passage has been a stumbling-block, and Mr. Mansel may have knocked his shins against it: "The moving forces which impel bodies through the same space are in the joint ratios of the quantity of matter moved and *squares of the velocities generated*." When Atwood wrote this, he did not anticipate that it would be read by men who ignored *time* in their dynamic disquisitions. It is strictly true, and confirmatory of the law of forces which I have attempted to establish, although apparently opposed to it. Let us examine. Assuming gravity = 32 ft. instead of $32\frac{1}{6}$:—

Moving forces. lbs.	Mass moved. lbs.	Space passed through. Ft.	Terminal velocity per second. Ft.
1	16	1	2
4	16	1	4

The space has been the same for both forces.

Here moving forces are $\frac{1}{4}$, terminal velocities $\frac{2}{4}$, and $\frac{2^2}{4^2} = \frac{1}{4}$; thus proving the strict truth of the above statement. Here some persons rest; but, in order to test the efficacy of two forces, they must be *allowed to operate the same time*. Using, then, the ordinary formula $t = \frac{2S}{v}$, we have $\frac{2}{2} = 1$ second in the first case, $\frac{2}{4} = \frac{1}{2}$ second in the other. If we allow the force = 4 to act for a whole second, as well as the force = 1, we shall have—

Moving forces. lbs.	Mass moved. lbs.	Space passed through. Ft.	Terminal velocity per second. Ft.
1	16	1	2
4	16	4	8

Here is moving force as 1 : 4, *which is in the simple ratio of the terminal velocities, and not as their squares.* Making the moving force constant, and varying the masses, we have—

Moving forces. lbs.	Mass moved. lbs.	Space passed through. Ft.	Terminal velocity per second. Ft.
1	16	1	2
1	4	1	4

Ratios.—Masses $\frac{16}{4}$, squares of the velocities $\frac{4}{16}$, forces $\frac{1}{1}$. But, observe again, motion lasts for a second in the first case, and half a second only in the other. Allowing a second for both, we have—

Moving forces. lbs.	Mass moved. lbs.	Space passed through. Ft.	Terminal velocity per second. Ft.
1	16	1	2
1	4	4	8

Here masses are $\frac{16}{4}$, and velocities $\frac{2}{8}$. Thus the masses *are in the inverse ratio of the velocities, and not of their squares;* AND THIS IS UNIVERSALLY THE CASE. It is needless to vary the masses in the same ratio as the forces, because it is obvious no variation of space or velocity could result. The passage cannot now be misunderstood, if it be borne in mind that GRAVITY is the *moving force;* and only INERTIA the *resistance.*

I merely add Atwood's theory of fluid resistance; which is Newton's theory; and it is the theory of truth. He puts $\frac{M}{m}$ = resistances in a given time. $\frac{V}{v}$ = velocities. $\frac{A}{a}$ = areas of planes. $\frac{N}{n}$ = densities of fluids. Then says, "The number of particles impinging upon the planes $= \frac{A}{a} \times \frac{V}{v}$, and the ratio of the forces of each particle respectively $= \frac{V}{v} \times \frac{N}{n}$, so that the ratio of the quantities of motions communicated to the planes, *in a given time*, by the fluids impinging perpendicularly, with the velocities Vv, will be the sum of the ratios $\frac{A}{a} \times \frac{V}{v} \times \frac{V}{v} \times \frac{N}{n}$: that is, the ratio of the quantities of motion lost *in a given time*, by the planes $A\,a$ moving with the velocities Vv respectively, or the resistance opposed to their motions, will be defined by the equation $\frac{M}{m} = \frac{V^2}{v} \times \frac{A}{a} \times \frac{N}{n}$."

It is impossible to misunderstand this. V^2 is the measure of a compound quantity produced in *time* through *space!*—resistance opposed for a period to "motions"—not the reaction of mere instantaneous impact.

But I must conclude. It is said that if some "Yankee skippers" get hold of a "craft" that does not suit them, they "beach" her. Mr. Mansel disposes of my steam-ship in this way. Not very logical—but very conclusive!

He admits that his "$C = 8c$" was wrong, and my "$C = 4c$" was right; but, *malgré* this, his arithmetico-algebraic conclusion remains intact! He is right, and I am in error! He reminds me of a dear old schoolfellow who had no relish for arithmetic. I have seen him, in a state of dubitation, place row after row of figures upon his slate—then open his "Tutor," and finding the "answer," put that at the bottom, as a sort of "*finale.*" On presenting his performance, and having his blunders exposed, he used to exclaim, "*It comes to the answer, Sir!*"

G. J. Y.

COMPASSES FOR IRON SHIPS.

To the Editor of The Artizan.

SIR,—The compass question has been much agitated, and a multitude of scientific opinions have been propounded in relation to this interesting subject.

Unfortunately, theory and practice have differed—not that theory, as promulgated by the Astronomer Royal and others has failed, but that practice has not followed in its wake in a sufficiently effective manner to render the latter a twin to the former.

Why is this? Economy. I have no hesitation in making the declaration, that if it were made imperative that a better class of instruments should be provided for iron ships—in fact, I may say for ships generally—the number of annual casualties would be considerably reduced—the lives of our valuable seamen would be preserved—the coffers of our underwriters would be in a state of plethora—and the horrors in our public journals, descriptive of shipwreck, would be greatly diminished.

The time has arrived when every conscientious man should lift up his voice and say, that the instruments of bygone times shall no longer be perpetuated.

Our forefathers knew not the effects of vibration on a delicate instrument through the power of a steam-engine. A legacy has consequently been left for the present age, in which prejudice and economy prevail too powerfully.

The compass made forty years ago for our Navy would no longer be tolerated; and I feel much gratified that certain peculiarities in the construction of the instrument for combating the evils alluded to have received the approbation of the highest authorities, when theoretically and practically developed.

Captain Carter, and Mr. Mainprize, Master of H.M. ship *Britannia*, state that at Sebastopol, in battering its walls, a compass invented by me was the only one that could be used for keeping the ship's head in a certain position, all the others in the ship not being able to resist the concussion from the broadsides delivered. Now in warfare this is a most important feature, for when guns bear upon a particular point, and a ship is enveloped in smoke from each discharge, a slight divergence from position would render the shot valueless.

I therefore state that all means calculated to resist concussion in an instrument so necessarily delicate, is the desideratum for all practical purposes, and also imperative for carrying out our scientific investigations theoretically.

I have the honour of enclosing you a copy of report sent, by command, to the Lords of the Admiralty, being the third and strongest in approbation of a practical magnetic apparatus, where all the appliances are provided for making an iron ship perfectly under the control of the master. I hope the long difference of opinion may pass away like mist before sunlight, and that the broad, naked, and simple truth will assert its position, despite of any animus arising from prejudice or economy.

I have made these remarks in order to show how necessary it is for shipowners either to provide, on their own account, proper instruments for their ships (easily effected in their contracts), or that underwriters, for *their* especial interest, should insist that instruments of the first quality shall be placed on board every vessel.

The shipowner would find it advantageous in shortening the voyage, the casualties would be less, and the underwriters would be the gainers.

After these prefaratory remarks, I should like to draw the attention of our scientific brethren to a few facts in relation to the perfect adjustment of iron ships.

Firstly. That no iron ship can be adjusted, nor can her compasses act in a natural manner, without the aid of magnets.

Secondly. An oscillatory action produced on the card, when a ship rolls, arises from magnetic causes, and not from unmechanical contrivance solely.

Thirdly. Unless there is a perfect combination of magnetism and mechanism under command on all parts of the earth, no iron ship is safe.

I have at last succeeded in providing the necessary material for grappling with any difficulty, let it be great or small, and I strongly recommend its adoption for these reasons.

The courses steered will be directly curvilinear, instead of the zigzag, consequently a voyage must necessarily be shortened: for when we hear of points of deviation in the southern hemisphere, it is quite obvious that there must be great loss of time in correcting the deviation of the ship's course; and when there is a necessity for steering in a narrow channel, in thick weather, the advantage of having an instrument trustworthy, none but the sailor can thoroughly appreciate.

The enclosed copy of report I hope will be convincing that, despite of all difficulty we have had to encounter, the commander of a ship can keep his compasses in order under all circumstances.

I have endeavoured, by my printed and personal instructions, to render the matter so simple that there is no master that has obtained his certificate, but is capable of comprehending it clearly.

I am, Sir, your obedient servant,

Liverpool, June. JOHN GRAY.

THE CONSERVATION OF THE MECHANICAL EFFECT OF FORCE.

To the Editor of THE ARTIZAN.

SIR,—Allow me once more to still further condense the definitions of the cube and square theories.

The "*cube theorists*" make it the indispensable condition, that a fourfold force through *a doubled space* is required when the speed of a steam-vessel is to be increased twofold: that is, the same paddle-wheel and engine must make twice the number of revolutions in a given time for that increased velocity; consequently, eight times the coal and steam is consumed. In opposition to this assumption, I admit that the velocity of the floats of the wheel must be increased in the above proportion, but I deny the requirement for the revolutions of the engines to be increased in the same ratio, for the following reasons:—

1st. That the mechanical effect of force is a constant quantity, and is always in the proportion to the force and *time*, and not to the force and *space* passed over by the piston.

2ndly. That if the diameter of the paddle-wheel is doubled when the fourfold force is employed, the same amount of mechanical effect is developed as if that force was applied to the original wheel making double the number of revolutions; therefore the sole element of contention may be thus expressed: *is the velocity of the force always in the proportion to the speed of vessel?*

I deny it. I assert *that one unit of space* is all that is required for any velocity of vessel, *the determination of that length being the most important problem in physical mechanics.*

Allow me to remind Mr. Mansel and the other controversialists that the subject under dispute is a question of mechanical effect (*foot-pounds*), not *vis viva*, the principles of which are never denied by any one possessed of an *ordinary knowledge* of mechanics. In my opinion, the principal cause of the dispute may be traced to the want of *a general definition of the distinction* between statics and dynamics in our educational treatises on mechanics, which may be thus expressed: A force (say on the lever) that requires a double amount of *space* to produce an equilibrium requires, when in equable motion, a double amount of *time* to produce a twofold mechanical effect—that is, *space* in statics corresponds with *time* in dynamics.

In corroboration of this distinction, Mr. Mansel furnished the complete proof (in the October Number of THE ARTIZAN, 1857) that a fourfold weight of *matter*, at a *double velocity*, only produces *a fourfold* mechanical effect, viz.:

lbs.		lbs.		ft.		seconds.	total ft. lbs.
20	will raise	12·	through	4	in	1	48
80	„	26·75	„	8	„	1	214
80	„	26·75	„	16	„	2	428

N.B.—Let it be remembered in the latter example that the 80 lbs. weight commences from rest in each second.

Now, if the 80 lbs. *raised* 48 *lbs.* through 8 ft. per second, the cube theory would be correct; but, as it only raises 26·75 through that space, we have Mr. Mansel's elaborate *algebraical proof* of the truth of the square theory, and my distinction between statics and dynamics.

I will now adopt the suggestion of "A Looker On," and produce a number

of facts, with the greatest variation in the velocity of the piston, to exhibit the *practice* of marine engineers, and to ascertain whether the velocity of the piston is essential in calculating the speed of a steam-vessel.

The vessels in the following tabulation are chiefly selected from the results of trials published by the Admiralty in 1856. The number before the vessel corresponds with the number of the experiment of the vessel in that list; the third column is the amount of force required for a plane the same area as the midship section, and the velocity of the vessel, viz., $F = A V^2$; the fourth column, the actual force obtained by reversing the rule of indicated H.P.; and the deduced speed (fifth column), the speed of a plane the same area as the midship section of the vessel and the mere actual force, obtained by the formula based on the conservation of the mechanical effect of force, viz.:—

$$\text{Velocity}^2 \text{ feet per second} = \frac{\text{Force} \times 1 \text{ unit}}{\text{Mid. Section}}.$$

The question for solution being, What is the cause of the variation of the actual from the deduced speed?

In the above tabulation it is assumed, if the velocity of the piston is essential in calculations of speed of vessel, *by its neglect* the vessels ought to have tabulated in the proportion of the velocities of the piston, which is not exhibited; consequently whatever may be the velocity of the piston, the amount of mechanical effect in one second *is equal and constant in quantity.* There is one important fact exhibited, which is certainly not creditable to the science of civil engineering, viz., the immense variation (300 per cent.) in the velocity of the piston in vessels with nearly an equal speed.

		Speed of Vessel.	Velocity of Piston.
	Hastings	11·32	6·50
	Russel	11·28	8·12
	Cornwallis	12·13	8·58
	Cruiser	11·15	3·42
	Minx	9·19	4·90
	Plumper	11·66	2·90
4th.	*Hogue*	11·64	5·35
	Rifleman	12·00	2·66
2nd.	*Forth*	15·80	9·50
	Seahorse	15·64	9·35
	Algiers	15·21	2·91
5th.	*Fairy*	16·66	2·25
	Miranda	18·08	3·56
1st.	*Pioneer*	19·09	6·83
5th.	*Flying Fish*	18·92	5·12
	Victor	19·43	6·83
2nd.	*Desperate*	18·08	3·10
10th.	*Fairy*	22·42	4·24
	Pera	21·34	4·33
	Cadiz	19·59	3·86

	Actual Velocity. Feet per Second.	Midship Section.	A V².	Actual Force.	Deduced Velocity.	Ratio of Speeds.	Ratio of Forces.	Velocity of Piston Feet per Second.	Ratio of Pitch to Diameter.	Revolution of Screw.	Speed of Vessel to Velocity of Piston.	Engine.	Remarks.
Hastings	11·32	725	92800	30541	6·48	1·67	2·78	6·50	1·02	78	1·74	Direct	High Pressure.
2. *Forth*	15·80	516	128484	48263	9·64	1·64	2·68	9·50	·83	114	1·66	Direct	High Pressure.
Seahorse	15·64	518	126910	48964	9·72	1·60	2·56	9·35	·83	112	1·67	Direct	High Pressure.
Russell	11·28	764	97028	39150	7·14	1·56	2·43	8·12	·79	97	1·39	Direct	High Pressure.
Cornwallis	12·13	726	106722	50474	8·36	1·45	2·10	8·58	·79	103	1·41	Direct	High Pressure.
2. *Hogue*	14·16	805	161000	78306	9·84	1·43	2·04	5·60	1·17	56	2·56	Direct	
2. *Cruiser*	11·15	332	41168	21180	8·00	1·39	1·93	3·42	·74	102	3·26	Geared	Rennie.
2. *Simoon*	14·70	555	119880	67913	11·04	1·33	1·76	4·37	1·03	52	3·36	Direct	
Conqueror	18·25	1122	373626	210996	13·74	1·32	1·74	7·33	1·41	55	2·50	Direct	5,665 tons displacement.
Satellite	19·26	404	149884	109838	16·46	1·11	1·23	6·82	1·47	63	2·82	Direct	
Minx	9·19	59	5015	4097	8·30	1·10	1·21	4·90	·87	196	1·87	Direct	145 tons displacement.
Minx, 1850	15·42	82	19434	22160	16·42	·94	·82	5·82	1·11	254	2·65	Geared	
2. *Confli t*	15·82	472	118000	97385	14·35	1·10	1·21	4·36	1·48	65	3·63	Direct	Bomerang Propeller.
3. *Confli t*	14·68	472	101952	83332	13·26	1·10	1·21	4·93	1·13	74	2·97	Direct	Propeller Cut.
Horatio	14·96	391	87584	73836	13·71	1·09	1·18	4·12	·93	80	3·63	Geared	
Archer	13·18	383	66259	55810	12·04	1·09	1·18	4·14	·81	124	3·18	Geared	
Arrow	18·59	209	72314	60388	17·00	1·09	1·18	5·41	1·18	93	3·43	Direct	
Assurance	18·82	240	84960	70608	17·14	1·09	1·18	5·80	1·45	87	3·24	Direct	
5. *Conflict*	15·91	470	118910	84054	13·34	1·09	1·18	5·13	1·13	77	3·10	Direct	Sphere attached to Ross.
Sharpshooter	15·93	237	60325	50104	14·52	1·09	1·18	3·82	1·12	114	4·17	Geared	
2. *Coquette*	18·42	238	80920	67503	16·82	1·09	1·18	5·78	1·45	82	3·18	Direct	
1. *Plumper*	11·66	188	42300	22000	10·77	1·08	1·16	2·90	·69	108	4·00	Geared	
Vulcan	15·09	545	124260	104600	13·82	1·08	1·16	4·40	1·13	66	3·44	Direct	
8. *Conflict*	15·91	471	119163	102067	14·69	1·08	1·16	4·16	1·46	62	3·82	Direct	Common Propeller Cut.
Surprise	18·75	244	85888	73022	17·29	1·08	1·16	5·86	1·45	88	3·20	Direct	
1. *Highflyer*	15·21	448	103488	90685	14·21	1·07	1·14	4·24	·80	101	3·60	Geared	
Miranda	18·08	336	109872	94720	16·79	1·07	1·14	3·56	·96	87	5·08	Geared	
Alacrity	18·37	236	79768	69400	17·14	1·07	1·14	5·73	1·45	86	3·20	Direct	
Algiers	15·21	1053	243243	211116	14·14	1·07	1·14	2·91	·82	6 9	5·22	Geared	Multiple 27 : 69.
1. *Duke of Wellington*	17·06	988	287508	245146	15·75	1·07	1·14	4·44	·90	66	3·84	Geared	Multiple 29 : 66.
4. *Flying Fish*	16·76	277	77837	68791	15·74	1·06	1·12	4·61	1·52	59	3·64	Direct	
4. *Hogue*	11·64	805	108675	99144	11·09	1·05	1·10	5·35	1·31	ɔ3	2·17	Direct	
1. *Megara*	17·23	383	113751	103052	16·40	1·05	1·10	4·94	1·11	74	3·48	Direct	
Niger	16·70	406	113274	102065	15·84	1. 05	1·10	4·27	1·39	70	3·91	Direct	
Ringdove	18·25	223	74259	66471	17·26	1·05	1·10	5·60	1·43	84	3·02	Direct	
Victor	19·43	264	99792	93886	18·84	1·03	1·06	6·83	1·86	82	2·84	Direct	
Wanderer	18·08	231	75537	70223	17·43	1·03	1·06	5·55	1·45	83	3·25	Direct	
5. *Flying Fish*	18·92	277	99792	94305	18·43	1·02	1·04	5·12	1·52	68	3·69	Direct	
Brunswick	13. 08	882	150822	145960	12·84	1·01	1·02	5·35	1·21	53	2·44	Direct	
1. *Pioneer*	19·09	273	99645	95988	18·73	1·01	1·02	6·83	1·86	82	2·79	Direct	
Rifleman	12·00	233	33552	34429	12·12	·99	·98	2·66	·91	89	4·51	Geared	Multiple 35 : 98.
2. *Rattler*	15·44	338	80782	84236	15·77	·98	·96	3·39	1·10	101	4·55	Geared	Multiple 25 : 103.
1. *Meteor Battery*	9·75	310	29450	31455	10·04	·97	·94	9·26	2·08	139	1·09	Direct	
4. *Desperate*	16·16	424	110664	141137	18·22	·91	·82	3·16	1·08	82	5·11	Geared	Multiple 34 : 74.
2. *Desperate*	18·08	388	126876	158347	20·19	·89	·79	3·10	1·08	82	5·83	Geared	Multiple 34 : 74.
10. *Fairy*	24·42	84	42252	53059	25·11	·89	·79	4·24	1·27	212	5·29	Geared	Griffith's Propeller.
5. *Fairy*	16·66	86	23650	60133	26·40	·63	·39	2·25	3·01	112	7·40	Geared	Lowes Propeller.
Pera	21·34	548	248752	173880	17·86	1·19	1·42	4·33	1·35	65	4·93	Geared	Rennie.
Cadiz	19·59	262	92366	64008	15·58	1·25	1·44	3·86	1. 46	..	5·05	Geared	
Rajah	16·69	209	58102	55521	17·08	·98	1·00	2·87	1·22	..	5·81	Geared	
Sultan	16·97	243	69012	57070	15·29	1·10	1·21	7·33	2·00	55	2·32	Direct	

These examples are sufficient proof of the fallacy of the "*cube theory.*" Take the *Minx* and *Fairy,* in which the speed is doubled, but by gearing the engines (equivalent to doubling the diameter of the paddle wheel) there we find the velocity of the piston is less than in the *Minx* at a speed of 9·19 ft. per second; then compare the *Russel* with the *Plumper* and *Rifleman,* there we find the velocity of the vessel is not reduced by *diminishing* the speed of the piston. The same facts are likewise exhibited by the *Seahorse, Forth,* and *Algiers,* where the velocity of the piston in the two former *is three times* that in the latter for an equal speed of vessel. Now as the low velocity of the piston in the *Miranda* and *Algiers* is the exception to the modern practice of civil engineering (direct acting engines), I can safely assert that the consumption of fuel and the wear and tear of the engines is 50 per cent. in excess of the actual

requirement, that the power of the steam engine—force × velocity of piston—is the greatest mechanical blunder of the 19th century, and that the loss entailed on the civilised world by the want of knowledge of the fundamental principles of mechanics may be safely estimated at £3,000,000 annually.

As a final illustration I will place before you four trials of vessels in which the necessary conditions are nearly equal, as a proof of the fallacy of the present rule for calculating the power of the steam engine, and the truth of my definition of that power, viz.:—

	Velocity.	Mid. Sec.	I.H.P.	Actual Force.
Miranda	18·08	336	613	94,720 lbs.
1st. *Pioneer*	19·09	273	1,192	95,988 „
5th. *Flying Fish*	18·92	277	877	94,305 „
Victor	19·43	264	1,165	93,886 „

In these similar vessels we have nearly a variation of 100 per cent. in the amount of indicated H.P., while in the *force* employed scarcely a variation of 2 per cent. Now if the application of theory to actual performances be a test of correctness, these vessels are a complete confirmation of the conservation of the mechanical effect of force, without adding the coefficients of those vessels deduced from the formula—

$$\frac{V^3 \times \text{Mid. Sec.}}{\text{I.H.P.}} = C,$$ which are respectively 680, 336, 443, and 351, or exactly in the proportion of the velocity of the piston.

I am, Sir, your most obedient servant,

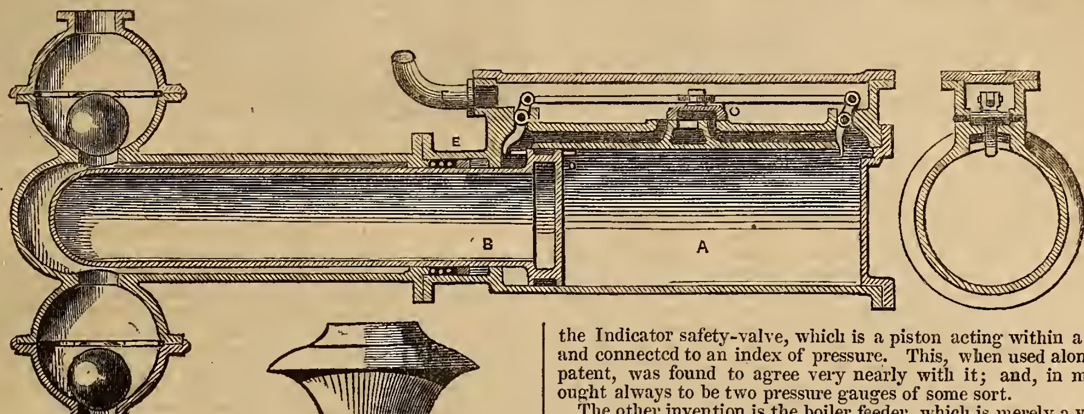
ROBERT ARMSTRONG.

SAFETY VALVES.—FEEDING STEAM BOILERS.

To the Editor of The Artizan.

SIR,—In your Number for June I see that Mr. Roberts, C.E., of Manchester, advocates a peculiar construction of safety-valve, in order to give speedy and effective relief to steam-boilers. As you will see by Fig. 3, it is the same for which I obtained a patent some years ago. I am very glad of the advocacy of so distinguished an engineer as Mr. Roberts; and I doubt not but Mr. R. will be equally glad to learn, if indeed he is not already aware of the fact, that this construction of valve has been fully tested, and with the most satisfactory results, corroborative of Mr. R.'s remarks. This valve was tried, among other places, at Crew Works of the London and North Western Railway Company, and minute particulars then written and sent to me shall be at your service, if required. In the meantime I shall merely state that the *top area* being made double that of the

Fi. 3.



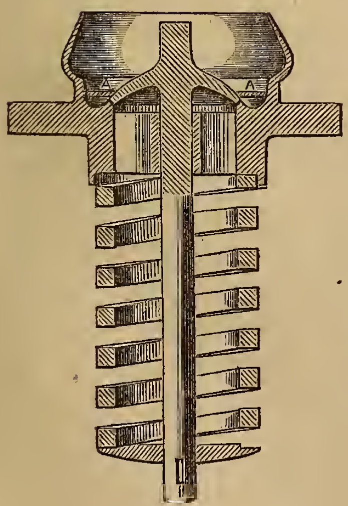


Fig. 1.

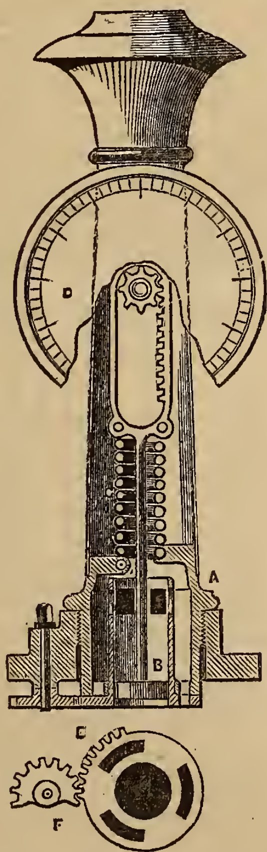


Fig. 2.

underside or steam way, such a valve would quickly reduce the pressure in the boiler to *half* that *at which the valve lifted*; and so also of other proportions. Hence it is chiefly suited for a *reserved* valve. It also compensates for the evils of a lever.

There are other two contrivances, of which I send you views, which are also connected with the safety of steam boilers, and both have been found to act well—the Indicator safety-valve, which is a piston acting within a tube or cylinder, and connected to an index of pressure. This, when used along with Bourdon's patent, was found to agree very nearly with it; and, in my opinion, there ought always to be two pressure gauges of some sort.

The other invention is the boiler feeder, which is merely a very much simplified *steam-engine and force-pump* in one. This has been found to maintain the water at any desired level, which every one will acknowledge to be essential to the safety of the boiler.

I am, Sir, yours respectfully,

Notting Hill. CHAS. RITCHIE.

ON CALCULATING THE PROPELLING POWER OF THE ENGINES OF STEAM-SHIPS.

To the Editor of The Artizan.

SIR,—Considering the character of THE ARTIZAN as a field and record of scientific discussion, some apology is, I think, due to you on requesting your insertion of such rudimentary correspondence as whether or not the required propelling power of a steam-ship varies as the cube of the speed to be attained (V^3), it being conceded that the resistance varies, *cæteris paribus*, as the square of the speed (V^2). And the same may be said for discussing in your columns whether or not, in solids of *similar form*, the analogous sectional areas are proportional to the square of the cube root of the solid contents ($D^{\frac{2}{3}}$). My apology for intruding these axioms in the pages of THE ARTIZAN, thus making it a novice's horn-book, is because a horn-book on steam-ship capability is really required; and I believe that great public good will result from public attention being directed by THE ARTIZAN to the subject matter of this correspondence between "G. J. Y." and myself, having for its object the introduction of some system for determining, by anticipation, though approximately, the mutual relation of displacement, power, and speed, in vessels to be built on any given type of form, and whereby the capabilities of steam-ships may be predetermined, by being made the subject of arithmetical rule, based on the ascertained performance of vessels of a similar type of build: such, for example, as the system of Mercantile Steam Transport Arithmetic devised and promulgated by myself, based on the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C$, a constant number for any class of vessels of similar form, if propelled by engines of equal dynamometric efficiency, with reference to their indicated H.P. Hoping that you will admit this apology for much of the rudimentary matter with which I may have to respond to the letter of "G. J. Y." which appeared in THE ARTIZAN, No. 185, pages 144 and 145, I beg, in the first place, to observe that your correspondent "G. J. Y." imputes *disingenuousness* to my not having interpreted his expression "miles" to mean the same as "knots," which he speaks of in the very next line. Now if "G. J. Y." does not mean what he writes, nor write what he means, nor adopt the received definition of terms, our correspondence becomes mutually unintelligible, rather than mutually "disingenuous." In such matters we must be specific.

On the matter of engine power, also, I apprehend that the difference between "G. J. Y." and myself is again simply attributable to our not attaching the same definite meaning to the word power. I am in hope, however, that the

steam tug-boat test suggested by "G. J. Y." will enable me to elucidate, in a manner satisfactory to him, what I mean by power. Admitting, therefore, as suggested by "G. J. Y.," that a large vessel is towed at $1\frac{1}{2}$ miles per hour by a tug-boat working up to 80 indicated H.P., of which the area of the two pistons is (say) 2,750 sq. in., the average working pressure thereon being (say) 8 lbs. per square inch, and the speed of the pistons being 120 ft. per minute, we have $\frac{2750 \times 8 \times 120}{33000} = 80$ indicated H.P., the indicated H.P. corresponding to the $1\frac{1}{2}$ miles speed. Now suppose we want the large vessel to be towed twice as fast, or 3 miles per hour, what must be done? Why, in the first place, the resistance to the vessel, and therefore the tensile strain on the towing-line, will be increased in proportion to the square of the speed—that is, in this case, four times; consequently, if the same tug-boat, engines and boilers, be adapted for meeting the case, the average working pressure on the pistons will have to be increased up to four times, or 32 lbs. per square inch; and as the speed of the vessel is to be twice as fast, we may suppose that the paddle-wheels will have to go round twice as fast, to effect which the strokes of the engine will be doubled, and the speed of the pistons will now be 240 ft. per minute; whence, by thus increasing the pressure on the pistons fourfold, and the speed of the pistons twofold, we have $\frac{2750 \times 32 \times 240}{33000} = 640$ indicated H.P., being eight times the indicated H.P. required for the $1\frac{1}{2}$ miles speed—that is, the power varies as the cube of the speed (Ind. H.P. $\propto V^3$). The consumption of coals *per hour* will, *cæteris paribus*, be increased in the same proportion, that is, as the cube of the speed; but the consumption of coal *per mile* will be as the square of the speed, for we shall now have eight times the power working only half the time per mile travelled; and this is found practically to be approximately true, provided the ratio of the effective to the indicated H.P. be the same in all cases.

As to the displacement ($D^{\frac{2}{3}}$), "G. J. Y." himself, I believe, admits that, *cæteris paribus*, in the case of similar vessels, the resistance at any *given speed*, and consequently the power at any *given speed*, will be proportional approximately to the area of the immersed midship section. For my own part, as before stated, I am sceptical on this point, for I am of opinion, as stated by me in the "Records of the British Association for 1856," that the depth of the centre of gravity of the immersed surface or midship section should be recognised as a function of the formula; but waiving this question in deference to "G. J. Y.," and conceding the proposition to be correct, it then becomes a mere matter of geometrical fact, subject only to the condition of *similarity of form*, that the areas of the immersed midship section will be proportional to the square of the cube root, or cube root of the square, of the immersed body ($D^{\frac{2}{3}}$), and consequently (*cæteris paribus*), indicated H.P., $\propto D^{\frac{2}{3}}$. Under these definitions, conditions, limitations, and admissions—which, I believe, are, one and all, conceded by "G. J. Y.," the combination of the above axioms into the form expressed by the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}} = C$, is a mathematical consequence, in which C will be approximately a constant quantity for vessels of the same type and condition, if propelled by engines of proportionally equal efficiency; and the various values of C that may be determined from the actual performances of vessels of different types, and differently circumstanced, will be indicative of the comparative dynamic efficiency of the vessels thus put in competition with each other; and the peculiar capabilities of different vessels, as respects their special adaptation for speed or for cargo, being thus developed, vessels may be designed or selected of such capabilities as, dependent on the mutual ratios of displacement, power, and speed, will best suit the requirements of any service.

Supposing now that, from the recorded performances of numerous (say 100) vessels, of specific but various types, the respective values of C have been ascertained, we may then, by collation of the types of form, assign the coefficient which will probably be realised by an intended or untried ship; and thus any two of the three quantities, V, D, and indicated H.P., being known or assigned, the third may be calculated. Every new vessel should thus have the value of the coefficient (C) determined by actual test trial, and if, on subsequent experience of the same vessel, it be found that she do not uphold her original coefficient, we may then infer that the vessel, as respects the condition of hull, or engines, or management, is defective; but whether the defect be in the hull, or in the engines, or in the management thereof, will demand special investigation.

As respects the Table put forward by me in The Artizan for March last, No. clxxxii., "G. J. Y." observes that the same numeral coefficient (C) will not apply to the same vessel at different drafts, because the type of immersed form will not be the same. This is critically correct, but for simplicity, and as my estimate only professes to be approximate, I have assumed one coefficient (215·5) as a mean for the whole; for it is surprising how little the coefficient and calculated speed of a vessel varies by the change of type from the light to the load line, provided the load draft lines retain the same character for sharpness which may characterise the light draft lines, and which appears to be peculiarly the case with the *Leviathan*. In constructing the Table, therefore, I did not attempt to attain this critical precision, but I conformed strictly to the heading thereof; and I shall be quite satisfied that the formula be tested by the figures as they now stand, excepting that from a recent publication by Mr. Grantham of the lines of the *Leviathan*, it appears that the displacements corresponding to the drafts of water are considerably less than set forth in my former Table, and which, if corrected, will produce the following results, supposing, as before, the coefficient of dynamic duty to be 215·5:—

Draft. Ft.	Displacement. tons.	Speed with 8,000 Ind. H.P. Knots.	Speed with 12,000 Ind. H.P. Knots.
20	14,850	14·19	16·24
25	20,100	13·26	15·18
30	26,000	12·53	14·34

Your correspondent "G. J. Y." still declines to state at what specific draft, midship section, displacement, or power, he calculates that the *Leviathan* will, on her trial trip, attain the speed of 19 or 20 nautical miles per hour. I can only say that, if at her 25 ft. draft, with a displacement of 20,100 tons, propelled by engines working up to 12,000 indicated H.P., the speed of $19\frac{1}{2}$ nautical miles per hour be attained, the coefficient (C) will, by the formula adopted by me, be C = 458, which would indicate a degree of constructive success in the conformation of the ship and engines which I cannot affirm to be impossible, but which far surpasses that of any vessel known to me at the present time, and which, if realised by the *Leviathan*, and not realised by vessels of smaller size (say of 3,000 tons displacement) on the same type of form, would indicate that the formula requires correction, to enable it to meet such extreme cases of application. The highest well-authenticated scale of dynamic duty that has come to my knowledge is that of a vessel said to be of 3,440 tons displacement, which, with engines working up to 1,624 indicated H.P., attained the speed of 13·15 knots per hour, thus producing a coefficient C = 319. With this coefficient, the *Leviathan*, at her 25 ft. draft, 20,100 tons displacement, and working up to 12,000 indicated H.P., would attain the speed of 17·3 knots an hour; and with 8,000 indicated H.P., the speed would be 15·1 knots, which would be very gratifying results—such as, in my opinion, are to be hoped for rather than expected, for I have never yet known a vessel of which the draft is only about one-third of the beam, as in the *Leviathan*, produce a coefficient above 215·5. And I may further observe, that should it be found necessary to introduce the depth of the centre of gravity of the immersed hull, or of the midship section, as a function of the formula, I apprehend that the result would be detractive from the high scale of advantage, as respects the ratio of power to displacement at a given speed, which, by the formula in its present state, appears to be the inherent property of superior magnitude with any given type of form.

I am, Sir, your obedient servant,

Woolwich Dockyard, 14th June, 1858. Chas. Atherton.

STEAM-SHIP RESISTANCE.

To the Editor of The Artizan.

Sir,—Dr. Eckhardt's mode of calculation tends to show that the prism has the least resistance, the wave line next, and the convex bow the most; and Mr. Atherton thereupon treats your readers to a triumphant *exposé* of the fallacy of the wave line system, but by what process of reasoning he does not state, nor can I imagine. The same mode of calculation has been tried by myself, and found useless, because no particle of water strikes a vessel in a line parallel with its motion, except that in a line with the keel. As I have elsewhere stated, that a cork dropped within a foot or two of the side of the stem of a steam-vessel in motion will never touch the vessel; and the effect of the remaining body of water displaced by the vessel's motion is simply to impinge upon the water already in contact with the vessel, and the resulting pressure is not that which Dr. Eckhardt's hydro-dynamics would show, but more or less according to the form of the vessel.

If Mr. Atherton adopts Dr. Eckhardt's calculations to prove the wave line to be bad, then he must maintain that the prism is the best form, which is absurd; the fact being that any vessel being so formed as to cause the water to pass an angle, must thereby lose speed and waste propelling power, whether that angle is formed at the stem, the stern-post, or any other part of the vessel's lines.

I am, Sir, yours very obediently,

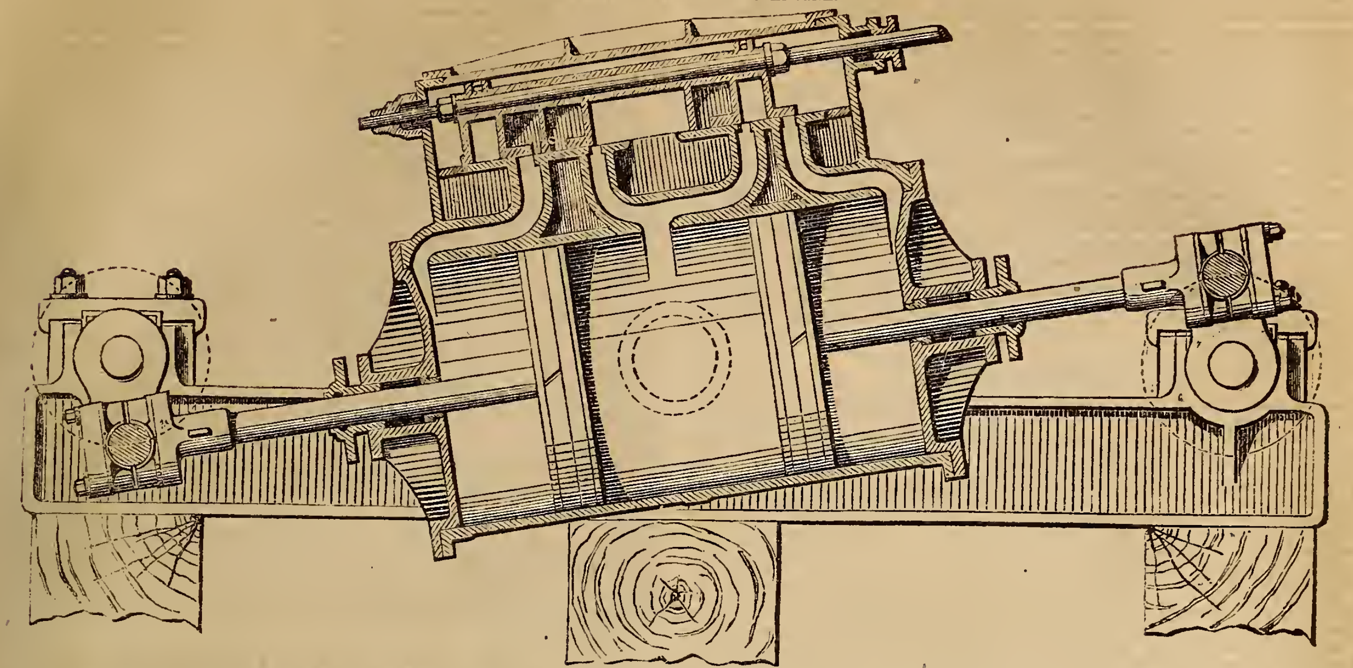
1, *Clifford's Inn, 15th June*, 1858. T. Moy.

DOUBLE-PISTON OSCILLATING ENGINE.

To the Editor of The Artizan.

Sir,—I know attempts have been made to work two pistons in an oscillating cylinder, and connect them direct on to two crank shafts suitably disposed, but they have failed, and on setting out geometrically the relative position of the cylinder and the two pistons with the dead centres of the two cranks during an entire revolution of the cranks, show one reason why they have not succeeded. It will be seen, moreover, that the slide arrangements for steam-giving, &c., have heretofore been defective. Now I think I have got over all the practical difficulties, and I send you a wood engraving of one of two combined oscillating cylinders, each cylinder having two pistons, with their rod ends connected to the two cranks, as shown. The ports and slide I have arranged answer admirably; and as I think the wood cut sent shows the whole so perfectly that I need not further occupy your space, I conclude by observing, that for light draft steamers, such as those excellent little iron gun-boats for the Indian rivers, constructed by Messrs. Rennie and Sons, where two screw propellers are employed, this kind of engine is admirably suited in every respect, and the necessity for setting the engines right and left, and in advance of each other, as arranged by Messrs. Rennie, would be avoided. Indeed, there are very many cases in which two screws, of rather smaller diameter, one placed on each side of the dead wood, would be infinitely better than hacking a vessel to pieces to put in one screw of sufficient size; or even when built suitably at the stern to receive a screw, the space is very limited, and does not afford the greatest convenience alike to the naval architect and the engine builder, for to get room for a screw of sufficient diameter and width of blade a useless overhang of the stern is given, and much cargo or passenger space is lost in this part of the vessel compared with the space due to the length of the ship over all; and thus it often happens with screw steamers—and if any of your non-marine readers will take the trouble to observe it on passing up and down the rivers of this country—that screw vessels now-a-days, what with their fine lines forward, which have weight without buoyancy, and the overhanging sterns, with the afterbody of the ships tapering away to allow of sufficient space in the stern frame for the screw which the engineer requires

DOUBLE-PISTON OSCILLATING ENGINE.



should be placed in her, they will see a sectiou something like that of the long taper fishing floats used by anglers—the only roomy part being the middle, the afterbody being sacrificed like the bow part or forebody; thus neither at head or stern is the buoyancy in proportion to the dead weight.

Now, Sir, excuse my pointing this out. I may be wrong, but I think I am right; but I know I am right about the advantage of two screws instead of one, not only for the advantage to the builder, but for the advantage to be derived from the better disposition within the stern of such a form of engine as I have here illustrated, and for the facility which it gives in navigating steam-ships in rivers, and for manœuvring war vessels when engaged.

I am, Sir, your obedient servant,

June, 1858. F. W. CROHN.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

WE have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

METROPOLITAN GAS SUPPLY.—A Select Committee of the House of Commons on Gas (metropolis) has just been appointed, including, *inter alia*, Mr. Byng (the mover), Sir Benjamin Hall, Mr. John Locke, and Mr. Alderman Cubitt.

EXPLORATION OF THE NIGER IN STEAMERS. — A "Central African Company" has been started to carry out, under a Government subsidy, a contract for the exploration of the Niger and its tributaries in steamers of light draught.

ALLEGED MISCONDUCT OF OFFICIALS AT WOOLWICH ARSENAL. — A Committee of members of the House of Commons have recently been inquiring into certain objectionable proceedings connected with the Casting Department of Woolwich Arsenal. The mysterious disappearance from the stores of various articles of fine-cast ornaments, &c., which were cast in the Royal Gun Foundry, such as busts of the Royal Family of Great Britain, France, Turkey, and Sardinia, the obelisk to the memory of the officers of the Royal Artillery who fell in the Crimea, &c., &c., would appear to be the chief ground of this inquiry.

FIRE IN A WOOLLEN MILL NEAR ROCHDALE.—Early on Sunday morning, June 6th, the woollen mill of Mr. James Whitworth, was nearly destroyed by fire: cause unknown. The floors being saturated with oil, the fire spread rapidly. Loss estimated at about £4,000.

AN "EASTERN COUNTIES AND DUTCH-RHENISH UNION TRANSIT COMPANY" proposes to convey goods *through* from London and other parts of England to various continental countries, free of all risk, *viâ* Eastern Counties line to Harwich, thence by steamers to Holland, to connect with the Dutch-Rhenish Railway.

RAILWAY AND CANAL LEGISLATION.—A Select Committee of the House of Commons, including the name of Mr. Stephenson, has been appointed to inquire into the best mode of securing the public interest, and diminishing Parliamentary expenses, in reference to railway and canal legislation.

THE NIGER EXPEDITION.—By the African mail steamer *Ethiope* advices have been received from the Niger Expedition to the 31st March. The *Sunbeam* was at the Brass River entrance of the Niger on the 22nd April, all well and in health, waiting for water to ascend to the confluence.

ENGINEERS OF THE "CAGLIARI" STEAMER.—On the 10th June the Chancellor of the Exchequer announced that the King of Naples had granted ample compensation (£3,000) to the engineers Watt and Park, and had placed the *Cagliari*, and all the crew, at the disposal of the Queen of England.

CONTRACTS WITH LOCAL BOARDS OF HEALTH.—Two contractors having sued the Local Board of Health of Worthing for the price of some sanitary works constructed for the use of the town, had obtained a verdict, but subject to a technical objection, reserved. The defence (characterised by the Lord Chief Justice of the Common Pleas as "a dirty defence") was, that the contracts were not in accordance with the terms of the Act of Parliament, namely, *not under seal*. Ultimately the Court reluctantly admitted the validity of the legal objection, and made the rule moved for absolute, to enter a verdict for the defendants.

THE RIBBON WEAVERS OF ST. ETIENNE.—One of the branches of the manufactures of France, through the late commercial crisis, has petitioned the Empress to patronise or introduce the use of figured ribbons. [The modern race of French manufacturers have evidently no leaning to the "*laissez-nous-faire*" (anti-State intervention) principles of their ancestors of the time of Colbert.—ED.]

DECREASE IN CONSUMPTION OF COAL IN LONDON.—Parliamentary returns show that the quantity of coal imported into London during last year is smaller, by 24,446 tons, than in 1856.

THE OFFICIAL TRADE RETURN for most articles of English produce or manufacture, for last month, shows a considerable *decline* from the corresponding month in 1857, the exportation of *hardware and cutlery* to Canada and the United States having fallen off about one-half.

DELETERIOUS VAPOURS FROM FACTORIES, &C.—The Belgian Government having appointed a mixed Commission of Chemists and Botanists to report on this subject, the Commissioners recommend *short* chimneys in preference to tall ones, on the ground of the former causing less dispersion of vapours prejudicial to health. [We need scarcely, perhaps, remark that this is contrary to the generally-received opiuion in this country.—ED.]

NITRE BEDS.—At Bahia, near San Francisco River, 180 leagues from the city of Bahia, a great natural deposit of nitrate of soda has been discovered, extending 60 miles along valley.

ROAD PAVING.—It has been proposed to pave steep inclines in streets with rows of stones alternating with strips of wood, the unequal wearing of the cross rows affording good foothold for horses.

HIGHLY TO THE CREDIT OF OUR MECHANICS, it appears, from the report of the Society of Arts Examiners, just published, that the first six persons to whom certificates (at the last examination) have been awarded are respectively a "Mechanic," a "Book-keeper," an Engineer," a "Shipwright," a "Warehouseman," and a "Gas Engineer." The three first prizes in arithmetic, algebra, and mensuration, were carried off by a "Working Engineer." In chemistry, by a "Worker in a Chemical Laboratory."

MUNICH (Bavaria) is to have its Crystal Palace Exhibition of Arts and Manufactures ("collected examples of the arts of all Germany during the past century"). To commence in July.

GOVERNMENT PATRONAGE OF ART.—In the House of Commons (17th June) the Chancellor of the Exchequer announced that on the extensive grounds at South Kensington, a space would be applied to an ornamental park and grounds not less in size than the enclosed area of St. James's Park, and around it there would be museums and galleries for valuable collections of art and science.

THE WEIGHT OF THE NEW "VICTORIA" BELL, LATE "BIG BEN," is 13 tons 10 cwt. 1 qr. 12 lbs., or rather more than 2 tons less than the former one. Diameter, 9 ft.; height outside, 7 ft. 6 in.; inside, 6 ft. $4\frac{1}{2}$ in.; thickness of sound-bow, $8\frac{3}{4}$ in.; of thinnest part, 3 in.

Marvellous Belfry.—The church of Bon Secours, at Rouen, is about to be supplied with a chime, with all the modern improvements recently effected; the chimes are to play special airs at Advent, Lent, Christmas, Easter, Whitsuntide, Ascension, and All Saints' Day, and a finger-board has been adapted to the chimes.

A Gunpowder-Mill Explosion, attended with loss of six lives, has taken place at the Kames Gunpowder Company's Mills, Kyles of Bute.

The Downing-street Public Offices Extension.—On the 22nd ult., the first real practical step was taken in this long-talked-of improvement. It is confidently expected that before many days have elapsed, the whole of the new site will be cleared—viz., from Fludyer-street on the north, to Crown-street on the south, and from King-street on the east, to Duke-street, St. James's, on the west. The building operations are to commence immediately.

Industrial Education of English Artizans.—In the House of Commons (21st June inst.), on occasion of the debate on the Kensington Museum Lands, &c., Bill, the Chancellor of the Exchequer made the gratifying announcement that "the Royal Commissioners not only desired, but were prepared, to carry out the original plan of 1852; namely, that there should be the means of giving *a complete industrial education to the artizans of this country;* and that the improvement of our manufactures should be sought through the medium of a scientific and artistic training for the operatives of England."

"Monostereoscope."—An improvement on the common stereoscope, under this title (from its representing only one subject, the picture being seen from each point of view, and by several persons at the same time), has just been invented by M. Gaudet, a pupil of Daguerre.

RAILWAYS, &c.

The Traffic Returns of railways in the United Kingdom for the week ending May 29 amounted to £481,620; and for the corresponding period of last year to £488,050, showing a decrease of £6,300.

Metropolitan Railways.—The gross receipts for the eight railways having their termini in the metropolis amounted, for the same week, to £196,378. Decrease, £13,084.

Mr. Brunel, C.E., it is understood, has gone to the continent for two years to enjoy quiet and recruit his health, after the anxiety and fatigue he has endured with the *Leviathan.*

The Bedford Level Corporation.—According to Earl Hardwicke, the newly-elected governor, the level is now completely drained and secured, the steam-engines have completed their work, and 95,000 acres are now drained.

American Railway Traffic.—The returns for the American lines indicate a probable speedy return to a satisfactory state.

French Railway Traffic.—The last returns of the gross receipts of the principal railways in France, from May 14 to May 20, show a gross total (passengers and goods) of 5,602,776 francs, being an increase on the corresponding week last year.

By a Collision on the Mons and Manage Railway, on the 2nd inst., no less than twenty-one persons were killed, and twenty-two wounded.

Railway Accidents.—Official reports on railway accidents which occurred in the first three months of the present year have just been published. They are by no means laudatory of the present state of locomotive arrangements and discipline.

Asia Minor Central Railway.—The promoters have notified that they do not at present intend to proceed with that undertaking. The deposits are to be returned in full; but the caution-money will remain lodged with the Turkish Government, in order to preserve the right to resume the scheme in better times.

West and North-Western of France.—The opening of this line for traffic is expected to take place in the beginning of July. By the inspection train, the distance from Paris to Cherbourg was accomplished in about ten hours.

Fatal Railway Collision.—By the collision (on the 2nd June) on the Belgian Railway, between Mons and Manage, sixteen persons, according to the "Constitutionnel" of Mons, were killed. The clothes of some of the victims were cut to pieces as cleanly as if with a pair of scissors.

Foreign Railway Shares.—The Board of Trade, in a notice in the "London Gazette" for Friday, June 4th, acknowledges the receipt of a copy of the translation of a French Imperial decree transmitted by Her Majesty's Ambassador at Paris, authorising the negotiation in France of foreign railway shares.

Cape Town to Wellington.—The Government of the Cape of Good Hope have advertised for tenders for constructing a railroad, with one line of rails, from Cape Town to Wellington. Distance, 51 miles. Estimated cost, under £500,000.

Extent of Railways in France.—According to the "Journal des Actionaires," the total concessions made to railway companies in France amount to 14,023 kilometres (five-eighths of a mile), of which 7,822 kilometres are now in working order, while 6,201 kilometres remain to be executed, at an estimated cost of between 1,700,000,000 francs and 1,800,000,000 francs.

New "Railway Writer."—An English resident in Turin, Mr. Smallwood, has in the Exhibition of Manufactures, &c., now open in that city, a portfolio so contrived as to enable a person, whilst travelling, to write with ease and steadiness, notwithstanding the motion of the carriage.

Losses on Foreign Railway Shares.—The "Times'" foreign correspondent from Paris, under date of June 7th, comparing the two dates of the 4th June, 1857, and 4th June, 1858, shows that even the most popular railway enterprises in France have suffered grievous depreciation, and that the shareholders in twelve of these undertakings have lost during the past year 433,626,000 francs, in round numbers £17,500,000 sterling, including, however, a total loss on the Credit Mobilier shares of 71,100,000 francs.

Border Counties Extension.—A petition, emanating from a meeting recently held at Hexham, is to be presented to the House of Commons, praying for a Royal Commission to inquire and report as to the best mode of railway communication between Central Scotland and the East and West Coasts of the North of England.

The Athens Railway (for the Piræus) has been tested and approved of.

Disobeying a Railway Signal.—At the Halifax Police Court, on the 7th inst., the engine-driver of an excursion train, conveying about 1,200 Sunday-school children and teachers on the down line of the Lancashire and Yorkshire Railway, has been committed for trial (but admitted to bail), charged with neglecting to bring his engine to a stand, in obedience to an auxiliary danger-signal, a down-line being occupied with empty carriages, whereby a collision, happily unattended with loss of life, was occasioned.

A Remarkable Railway Accident occurred on the 8th inst. on the line of the Midland Railway, near Desford. A number of men were repairing the line, when on the approach of a fast train from Burton and Manchester, and on the signal to clear being given, one of the workmen, an aged man, attempting to cross the rail, was instantly knocked down and killed. One of his legs—cut clean off—was cast into an adjoining field, about 40 yards from the line.

The Shareholders of the North of Europe Steam Company, after a stormy discussion, have passed a resolution confirming a proposal to wind up the concern, and appoint liquidators.

A Railway Mistake.—At a special meeting of the *Eastern Counties* Company, to consider certain Bills now before Parliament, the Chairman stated that one of the Bills—namely, that to authorise the Waveney Valley Railway Company to alter their line, hitherto worked by the Eastern Counties—was rendered necessary, as the Waveney Valley Line had been projected on *the wrong side of the river*, and they now wanted power to carry it on the other side."

The Export of Steam Engines from this country, for the last month, has been of the declared value of £107,651, against £77,087 for the corresponding date in 1857. Of machinery (other kinds), £217,366, against £185,971. The steam-engines were chiefly for Spain, Russia, India, and Australia.

Communication by Signal between Guards and Engine Drivers.—The Midland Railway Company have adopted the plan of a wheel, placed in the guard-van at the end of each train, and a stout line passed round the wheel, and carried along the sides of the carriage to the engine. By turning this wheel, on the discovery of danger, the guard can instantly set the whistle in action, and alarm the driver and other guards.

St. Dizier to Gray.—The opening of this line to the public is announced for the 1st of July inst.

Smoke from Locomotive Chimneys.—The Grimsby magistrates have fined the Manchester, Sheffield, and Lincolnshire Railway Company £5 and expenses, for using a locomotive not consuming its own smoke.

A State Railway Carriage, to be used by the Pope on the occasion of the inauguration of the Roman railway lines, is being built at Paris. Several artists are engaged in painting and decorating it. One part, at least, of the arrangement is novel and characteristic—it will contain a complete set of rooms, "*including an oratory.*" The cost of the vehicle is 10,000 francs (£4,000).

Algerian Railway.—The earthworks from Algiers to Blidah and Amourah, which were commenced last May by the Army (military convicts, we believe) of Africa, are proceeding rapidly, being already completed as far as Boufarck, 25 miles from Algiers.

The Riga and Dunaburg Railway has been commenced.

The Directors of the Bordeaux and Cette Railway Company have commenced a prosecution against the director of the *Phare de la Loire*, for having announced that their railway was sold to the Orleans and Mediterranean Companies, such statement being false, and punishable by law.

The French Government, it is reported, has consented to come to the aid of the railway companies, by guaranteeing interest on the sums expended on new branch lines not yet executed, and concerning which certain unfavourable reports as to their ultimate productiveness have been recently in circulation.

A New "Railway Departure Indicator" has been invented by M. Regnault, one of the chief functionaries of the Western of France, for announcing the departure of trains at the different stations along a railway line. The apparatus consists of a dial-plate, with a hand, which may move right or left, according to the direction in which the train is to start. The station-master at the terminus from which the departure takes place has only to press with his finger on a knob with which the dial-plate is provided to make all the apparatuses of the same kind along the line mark the departure. The hands remain in the same situation *even when the communication is interrupted*, and—this is the most important point—should an inattentive station-master press on the knob of his indicator while the hand marks the impending arrival of a train, *the hand will not obey this wrong impulse*, but remain where it is, and thus call the station-master's attention to the mistake he was about to commit.

Central Illinois Railway.—The Report just issued to the shareholders by the gentlemen deputed from London to make a thorough investigation into the affairs of that undertaking, although satisfactory on every point, is yet insufficient to cure the daily increasing and apparently unaccountable distrust evinced towards it.

Spanish Railways—Madrid.—On the 12th June took place a grand "inauguration" of the branch from the Alicante Road to connect Toledo with Madrid. M. Salamanca is the constructor of this line, 23 kilometres in length. The Archbishop of Toledo *blessed the locomotives!*

Munich (Bavaria).—Four railroads now run into this ancient capital, which dates its foundation from the eleventh century.

New Lines.—Another first-class line has been recently opened—viz., that of the Glasgow, Dumbarton, and Helensburg Railway.

Besancon to Belfort.—This new line was opened to the public on the 1st of June inst. It is 60 miles long, and completes the great artery from the Mediterranean to the Rhine, connecting Marseilles and Lyons on the one hand, with Strasbourg, Alsace, Germany, and Western Switzerland, on the other.

Western of France.—A trial trip has been made on the section between Caen and Cherbourg, preparatory to the official opening of the line, which is announced for the 7th August next.

Mont-Cenis.—The works for the *piercing of Mount Cenis* are being carried on day and night with great activity, both on the side of Bardonnechi and Modena. By an arrangement, peculiar, we believe, to this colossal undertaking, an extra inducement to exertion is offered to the operatives, *their salary being increased in geometrical proportion to the work executed.* On the side of Bardonnechi they have descended to the depth of 330 ft., and of Modena to 450 ft. The entire line will require ten years for its execution.

A Fatal Railway Accident (one person killed and several wounded) occurred June 20, on the South-Western Railway, near Bishopstoke Station, by the breaking of the coupling-chain and consequent overturning of a carriage, one of a Sunday excursion train, with from 600 to 700 passengers.

TELEGRAPH ENGINEERING, &c.

The Atlantic Cable.—Summary of the month's progress.—An entertainment was given at Southampton by the captain and officers of the *Impregnable*, 104, flag of Port-Admiral Sir B. Reynols, on board that ship, in Hamoaze, to Capt. Hudson, of the U.S. steam-frigate *Niagara*, and his officers. The company drank toasts to "The officers of the *Niagara*," and "The successful laying of the Atlantic Telegraph." The *Niagara* and *Agamemnon* left Plymouth Sound on the following evening on an experimental trip for the west coast of Ireland, attended by the paddle-wheel steam-vessels *Valorous*, 16, and *Gordon*, 6. On the 31st of May the experimental squadron arrived in latitude 47° 12′ N. long. 32° W., about 200 miles from Ushant; depth of the sea, 2,530 fathoms, or about 2⅞ miles. The cable was spliced four times. All the experiments were successful. The cable will be submerged by both ships from *the centre of the Atlantic*, instead of commencing *from the Irish coast*, as was the case last year. The rendezvous of the two ships in mid-ocean, for which the squadron steers in leaving to lay down the cable, is 52° 2′ N. lat. 33° 18′ W. long. Where the American side of the cable will be landed is 47° 49′ N., 54° W. The telegraph-house at Valentia is in 51° 56′ N. 10° 25′ W.; distance between the two points, 1,720 nautical miles. The Expedition has sailed.

Red Sea Telegraph Route.—Soundings are being taken by H.M.S. *Cyclops*, on the line proposed along the eastern shores of the Red Sea to as far as Jiddah, thence to the Straits of Bab-el-Mandel and Aden.

A practicable and safe route for the telegraph wires is also proposed along the eastern shores of the Gulf of Suez; the wires to terminate at a station in one of the small harbours north and east of Ras Mahommed, the native pilots stating that Sherms Shikh and Ul Moyah are the best.

"Autographic" Telegraph.—Signor Bonelli, the director of Sardinian telegraphs, has recently invented a (alleged) new electro-chemical telegraph, by means of which hand-writing (hence probably the name) can be transmitted. [Our readers may remember that an invention of an apparently similar kind has been long since patented in this country.—Ed.]

Electric Telegraph in Australia.—The progress of the Inter-Colonial Telegraph line, for the federal union of our southern and eastern Australian colonies (including a submarine cable to cross the straits, so as to connect Tasmania with the general system), would appear, by last advices, to be highly satisfactory.

Late advices (up to the 15th April last) state: "We are in correspondence by the

ELECTRIC WIRE with all our gold fields and with all the principal towns of the interior. Our telegraphic system has penetrated the northern colony of New South Wales, and reached the boundary of South Australia. In the course of a few weeks the submarine cable will place us in communication with the neighbouring island of Tasmania."—*Australian Argus.*

MILITARY ENGINEERING, &c.

PORT OF MARSEILLES.—Capt. Auzet, of the Engineers, has prepared a plan, to be presented to the Emperor, for the complete defence of the port of Marseilles.

A NEW MORTAR, the invention of Messrs. Dodds, of the Holmes Iron Works, near Rotherham, has been tried on the Doncaster race-course. Its chief novelty consists in the missile used having a shaft, which is feathered with zinc plates to give steadiness to the flight of the missile. The experiments are to be repeated under the inspection of an officer from Woolwich.

NEW BARRACKS.—In the estimates for 1858-9 the sum of £181,408 is proposed to be expended for the erection of new barracks this year, including £109,000 for permanent Barracks at Aldershott, and £41,000 for new barracks at Gosport, Hants.

FIRE ARMS.—An improved breech-loading fire-arm has been invented and patented by G. W. Morse. One of the improvements consists in the application of nippers moving irrespectively of the breech-slide, thereby grasping the cartridge and subsequently withdrawing it from the gun while the breech-slide is being retracted.

MANUFACTURE OF GUNPOWDER.—A recent (alleged) improvement in the manufacture of gunpowder, patented by Mr. H. Hodges, consists in admitting to the usual mixed ingredients a sufficiency of steam to damp the composition, dissolve the saltpetre, and soften the sulphur; by these means the saltpetre is more intimately blended with the other ingredients.

COMPARATIVE MERITS OF THE "LANCASTER MUSKET" AND "ENFIELD RIFLE."—Colonel Lane Fox, in a Report lately read at the United Service Institution, states that "actual practice has proved the 'Lancaster Musket' not only not inferior, but, if anything, a superior weapon to the 'Enfield Rifle.'"

A MODEL OF SEBASTOPOL, the Russian stronghold in the Black Sea, has just (June 22nd) been added to the United Service Museum, Whitehall, and visited by Her Majesty. The work was executed by Col. Hamilton, C.B., Grenadier Guards. It is considered by competent judges to be extremely accurate, the details being chiefly based upon the survey of the officers of the Royal Engineers.

THE NEW "GOSSAMER CARTRIDGE," the invention of Captain Norton, has been successfully tried at Tilbury Fort with the Enfield rifle. Its chief object is to prevent the necessity of the soldier biting off the end of the cartridge. The powder is enclosed in a small bag of thin paper, strengthened by a casing of cotton net. The flash of the percussion-cap is sufficient to penetrate through the thin paper by the openings in the network, and to fire the charge. It is considered to be a great improvement on the common cartridge.

MARINE ENGINEERING, SHIPBUILDING, &c.

A NEW SCREW STEAMER, of 1,900 tons, and 400 H.P., named the *Salsette*, has been built for the Peninsular and Oriental Company, by Tod and M'Gregor, of Glasgow.

THE four steamers mentioned in our last as recently built by White, of Cowes, for commercial service in the Turkish waters, sailed from Southampton for their destination on the 31st May last.

MONOPOLY OF SHIP NEWS.—A petition is to be presented to the House of Commons, from the Chamber of Commerce of Edinburgh, against the monopoly assumed by the Customs Annuity Benefit Society to publish mercantile and shipping intelligence.

VESSELS AND TONNAGE.—At the twelve principal ports of the United Kingdom in last year (1857) there entered inwards 27,755 vessels, of 7,893,057 tons; and cleared outwards 26,307 vessels, of 7,632,024 tons.

LIFE-BOATS.—At the quarterly inspection by the local committee of the Bideford Branch of the Royal National Life-Boat Institution, on the 29th of May ult., the exercise of the Appledore and Braunton life-boats came off with complete success. The three life-boats, *Petrel, Mermaid*, and *Dolphin*, were much admired for their power and efficiency.

AMERICAN WAR STEAMERS.—The "New York Herald," May 26th, announces that the Brooklyn Navy Yard is busy fitting out war steamers "to protect our (American) merchant men from the insolent attacks of British cruisers." The construction of six new steam-sloops of war has been authorised by Congress, and an addition of thirty more of a similar kind is talked of.

H.M. SCREW STEAM-SHIP "RACER," 11, recently built at Deptford, was to receive her masts at Woolwich on the 7th ult.

THE French maritime company called the MESSAGERIES IMPERIALES possesses in naval materials, afloat and in the dry docks, property officially valued at 33,872,825f. Number of steam ships afloat, 45, with 10,260 H.P.; registered tonnage, 21,448.

THE BORDEAUX AND CETTE RAILWAY COMPANY AND SOUTHERN CANAL COMPANY have, through the mediation of the Minister of Public Works, arranged their differences, which had led to a system of competition alike injurious to both undertakings.

LINES OF STEAM-VESSELS AND METHOD OF PROPELLING.—Improvements in both of these directions have been patented by Mr. H. Clark. The vessels are to be formed with such lines that when propelled, their tendency shall be to skim over the water; *i.e.*, with a flat bottom throughout a considerable portion of the length, while the bows and the run are a continuation of the flat surface, but at an angle of inclination. The Archimedian screw, as the propeller, is to be above deck, in the air, and to rotate at a high velocity.

ANOTHER inventor and patentee, Mr. C. C. James, relies for propulsion on the direct action of the pressure of steam upon the water. Cylinders, furnished with pistons, project from the stern of the vessel, and into and from these cylinders the external water has free ingress and egress. By the action of steam, cylinders in a direct line with them, and driving a rod common to both sets of pistons, act upon the water of the first cylinders, and the vessel is thrust forward.

THE USE OF STEEL *as a material for the construction of vessels*, which, with light draft of water, require to be of considerable strength, appears to be on the increase.

THE small steam-launch for the Livingstone expedition up the Zambesi River, was the first practical trial of a STEEL STEAM-VESSEL.

A STEEL STEAMER, the *Rainbow*, 160 tons, for the navigation of the Niger, has just been launched at Mr. Laird's, Birkenhead Yard.

THE NEW SCREW STEAMER, *Royal Bride*, which is to take the Australian mail, and to leave Plymouth on the 3rd July, amongst other novelties in its construction, has a contrivance for *closing up the screw* when its action is not required, an improvement which, it is hoped, will facilitate a speedy passage.

NEW (PROPOSED) MAIL LINE BETWEEN GALWAY AND NEW YORK.—At Southampton, on the 9th June, trial was made of the new ship *Indian Empire*. In passing the Government "measured ground" in Stokes Bay, the "knot," or nautical mile of 2,026 yards, was run in four minutes forty-six seconds, with 16½ revolutions per minute. Trial satisfactory. She left for Halifax and New York (expected passage, eight days), with the Government mail bag, on the 18th ult. The "Dublin Mail," however, expresses doubts on the subject of the projected change of route, and even hints that the railway authorities in league with Liverpool have thrown cold water on the affair.

PROGRESS OF STEAM NAVIGATION IN ENGLAND.—A Parliamentary Paper shows the astonishing development, during the last few years, of steam-vessel building in this country. The number of steamers engaged in the home trade has advanced from 312 in 1849, with tonnage of 54,089 tons, to 388 in 1857, with a tonnage of 92,481. Total number of steamers built and registered in the United Kingdom, between 1843 and 1857, 1,805. Proportion of steamers built to sailing vessels was, in 1857, 21·71 per cent. The general increase has been from 414 steamers, with tonnage of 108,321 tons, employed in 1849, to 899 steamers, with tonnage of 381,363 tons, employed in 1857.

FRENCH WAR STEAMERS.—A sum of 75,000,000 francs is to be applied to the blindage (sheathing with iron-plates) of the steam-ships of the new armament, and 12,000,000 francs to the construction of steam machinery of 150, 600, and 900 H.P.

NEW LINE OF (MAIL) STEAM-SHIPS BETWEEN GALWAY AND AMERICA.—The *Indian Empire* (paddle-wheel steamer, 5,000 tons burden, 1,000 H.P., built for the Atlantic Steam Navigation Company), the pioneer of this new system of communication between England and the United States, left with the mail for America on the 19th June. In entering Galway Bay she had met with a mishap, having, through the alleged ignorance, or worse of two of the local pilots, struck upon St. Margaret's Rock, but beyond a delay of two hours, sustaining no material damage. The pilots have been committed for trial at the approaching assizes. The "Dublin Express" goes so far, indeed, as to hint at "a diabolical conspiracy with Liverpool," "commercial jealousy," &c., with reference to this undoubtedly mysterious affair.

OCEAN STEAMERS.—Great Britain has 1,670, of 666,330 tonnage; America only 57, of 94,795 tonnage.

LIFE BOATS.—A fine specimen of the boats of this class, built by Messrs. Forrest, of Limehouse, from the design of the assistant shipwright of Woolwich Dockyard, was shipped on the 19th June inst., on board a Russian steamer, for Russia. A sister boat to the above is being built by order of the Board of Trade, for presentation to the Port of Calais, in testimony of the gallantry of some seamen of that port in rescuing a British subject from shipwreck off that coast. [We have reason to fear that the last was one of the six life-boats stated to have been destroyed in the late extensive fire, by which the premises of Messrs. Forrest, who are also builders to the National Life-boat Institution, suffered so severely.—ED.]

AT PEMBROKE, 11th June, the LAUNCH of the magnificent first-class steam-frigate *Orlando* took place. It is the first of the new class, 300 ft. in length; 3,726 tons burden; armament of the heaviest calibre, and of greater length than the *Wellington*, which is of 140 guns.

THE "NEW VESSELS 700 FEET LONG," lately announced as being in course of construction at Liverpool, turn out, it appears, according to a correspondent of the "Builder," (12th June) to be nothing more than a train or line of barges linked or joined together, the idea of which is due to the late Sir Samuel Bentham, a notice of which, and an account of the first used by him, some sixty years since, appear in a former Number of THE ARTIZAN.

AUGER-WORM IN TIMBER.—A most destructive timber disease, called the "auger-worm," nearly as ruinous as the "rot," has been discovered in the paddle-wheel steam-sloop *Barracouta.*

GAS ENGINEERING (HOME AND FOREIGN).

A SEVILLE GAS COMPANY, with a guaranteed capital of £30,000, under English management, is being formed and excites some attention.

THE ORIENTAL GAS COMPANY, formed in 1853, for introducing the use of gas into British India, held its fifth annual meeting at the London Tavern, on the 26th May last.

THE LIGHTING OF CALCUTTA WITH GAS proceeds favourably, notwithstanding various local and other difficulties. Up to February last, there were 299 public and 741 private lights.

THE subject of the CONTAMINATION OF THE LONDON WELL AND SERVICE-PIPE WATER, by the escape into them of coal-gas, is now occupying public attention.

THE WATERING-PLACE OF LLANDUDNO (North Wales) is being lighted by gas, the works for which are being constructed.

WATER SUPPLY—METROPOLITAN AND PROVINCIAL.

MANCHESTER.—The available supply of water for the domestic use of the city does not exceed from 5,000,000 to 6,000,000 gallons per day—altogether insufficient, it appears, there being no less than 5,900 dwellings, which only pay 1s. per annum for an unlimited supply.

BOMBAY.—Up to 1855 the supply was deficient in quantity and bad in quality. By the reservoir works lately constructed in the Valley of the Goper, the available supply from the storage reservoir (the Vehar Basin, or artificial lake, will be about nine thousand million gallons.

GLOUCESTER.—The Board of Health has authorised the outlay of a further sum of £22,000 to increase the supply, by constructing a store-reservoir under Birdliphill, about 7 miles from Gloucester.

LIVERPOOL.—"A scene," according to the "Liverpool Chronicle," occurred at one of the late weekly meetings of the Water Committee, relative to the alleged discrepancy between the unfavourable chemical analysis of samples of filtered Rivington water, by Mr. Spencer, on the one hand; and that of the local analytical chemist to the Queen's College, Professor Hamilton (favourable), on the other.

HUDDERSFIELD.—THE HOLME RESERVOIRS.—The rate (£100) assessed by the overseers of Austonley on the Bilbery Reservoir (the scene some years since of the calamity known as the Holmfirth flood), and appealed against by the directors, has been confirmed by the Local Bench of Magistrates.

HARBOURS, DOCKS, CANALS, &c.

SUEZ CANAL.—In the course of the debate in the House of Commons on the, of late, much-contested project of making a canal across the Isthmus of Suez, Mr. Stephenson pointed out the physical and moral difficulties in the way of forming the canal, which, "owing to the two seas being upon a dead level, *would have no current*, and would be, in fact, a ditch. In his opinion it would be a most abortive undertaking."

PORT PHILLIP DOCKS.—A Prospectus has been issued of a Port Phillip Dock Company, with a preliminary capital of £7,500, to be increased to £300,000 on an Act of Incorporation being obtained. At present the colony of Victoria, notwithstanding her maritime trade, is without sufficient dock accommodation.

LONDON CUSTOM HOUSE AND VICTORIA DOCKS.—Electric telegraph signalling has been lately introduced into the system of delivering bonded goods as between the London Custom House and the Victoria Docks, the result being a great saving of time and trouble, orders from the Custom House authorities for the delivery of goods bonded at the Victoria Docks being now transmitted as electric telegrams.

"INTER-OCEANIC" CANAL (ATLANTIC AND PACIFIC) ACROSS THE ISTHMUS OF NICARAGUA.—An important convention has been concluded and signed between the governments of Costa Rica and Nicaragua on the one part, and M. Felix Belly (acting on behalf of M. Millan and Co., of Paris) on the other, relative to the concession of an "inter-oceanic" canal by the River San Juan and Lake Nicaragua; in other words, authorising the construction of a canal between the Atlantic and Pacific Oceans by an international Company, which it is proposed to form without distinction of nations, and under the joint guarantee of the governments of France, Great Britain (?), and the United States.

NEW OCEAN-MAIL (STEAM) ROUTE FROM AMERICA.—The Committee on Post-Offices of the American House of Representatives have recommended new ocean-mail routes, to consist of the Collins' Line to Southampton, instead of Liverpool; a line from New York to Havre; a line from Gluchstadt, *viâ* Plymouth and Rotterdam; and a line from New Orleans, *viâ* Havannah, Bermuda, Fayal, and Santander, to Spain.

PIERS AND HARBOURS.—In the Commons, on the 8th June, a Bill "To Encourage and Facilitate the Erection and Improvement of Piers and Harbours in Great Britain and Ireland," was brought in by Mr. Paull, and read a first time.

AN IRON LIGHTHOUSE FOR RUSSIA, to be erected upon the Island of Seskar, has been constructed by Messrs. H. and M. D. Grissell, at the Regent's Canal Iron Works,

Hoxton. It is furnished with the revolving Dioptric Light, technically known as the "Catadioptric Light," on the system of Fresnel, from its combining reflection with refraction.

The Sunderland Docks appear to be unexpectedly coming into notice, as affording greater facilities for trade with the Baltic and the northern parts of Europe than any other port on the East Coast, more especially for the importation of grain and the export of the manufactures of Lancashire and Yorkshire.

The Foundations of Dover Pier were last year extended 113 ft. During the quarter ending the 5th April last, a length of 47 ft. of the pier was raised from 12 ft. below low water level up to 4 ft. below that level; and a further length of 38 ft., from 30 ft. below low water to within 8 ft. of low water.

The Solemn Inauguration of the Port of Cherbourg has been adjourned to the 7th August.

The Works now in Progress at the Canal at Venice were, on the 2nd inst., visited by the Archduke Ferdinand Maximilian, Governor of the Province.

Swansea.—The erection of the new and long-projected docks at Swansea is progressing with great activity. Steam-pumps are in action night and day, clearing the portion of the docks already finished. A sea-wall is to be constructed on the margin of the Bay, forming an esplanade of great length.

Chelmsford.—The Board of Health Sewage Works are now in operation. The sewage is being pumped into the tanks.

BRIDGES.

The first tube of the Albert Tubular Bridge across the Tamar, to connect Devonshire with Cornwall, has been lifted to the required height. The other tube for the eastern side is in rapid course of completion.

The German Diet, at the instance of the Grand Duchy of Baden, Rhine, has sanctioned the construction of a fixed bridge on the Rhine, between Strasburg and Kehl.

Chelsea Bridge.—By the New Chelsea Bridge Bill now before Parliament, Government propose to abolish the toll on this bridge when it has produced sufficient to repay the money advanced for its construction, without interest.

American Railway Bridge Accident.—A frightful accident on the New York Central Railway has been attended with the loss of eight lives, and the maiming of forty persons. It occurred on a railway bridge over the Sanquoit Creek, about 4 miles west of Utica. Two trains, each on its own track, the Cincinnati express and the Utica (West), met and crossed on the bridge; but the combined weight of the two crushed the north side of the structure, and the trains were precipitated into the creek. The accident was caused by the extreme rottenness of the bridge.

Victoria Station and Pimlico Railway.—In the House of Lords, June 21st, on the motion of Lord Redesdale for the third reading of this bill, the Earl of Carnarvon moved that the First Commissioner of Public Works should have leave to appear by counsel against the same. Lord Stanley of Alderley alleged as the reason for this, as he admitted, "unusual course"—(we presume he alluded to the Government)—"the expression *of an opinion by a member of the Royal Society* (!) that if the Bill was passed, a bridge would be thrown across the Thames, which would destroy the bridge recently erected at Chelsea." Further consideration postponed till Lord Derby should be in his place.

BOILER EXPLOSIONS.

Locomotive Boilers.—Colonel Wynne, in his late Official Report on (Railway) Boiler Explosions, states that "the majority of these explosions occur, as his experience proves, under the ordinary working pressure of the steam, and may always be traced to the boiler being worn out, or to some marked defect in its construction, and *not* to steam of an extreme tension generated by the driver loading the safety-valves—a favourite but silly and untenable theory of locomotive superintendents who wish to relieve themselves from blame."

The Late Accident on the Brighton Railway.—The explosion of a boiler at the Caterham Junction of the Brighton Railway, on the 8th of February last, is ascribed, in the official report, "to the wearing of the copper."

For Prevention of Boiler Explosions.—A new adaptation of the French system of fusible metal taps or plates has recently been patented in this country. Below the water-line a pipe extends out of the boilers; a stopping-plate of fusible metal, with which the pipe is furnished, melts when the water-level shall have fallen so low as to admit the steam into the pipe.

A Fatal Boiler Explosion has occurred at Mr. Rawson's Worsted Factory, Churchgate, Leicester. The victim, William Hemans, went too soon, it appears, to clean out the boiler after the steam had been let off. On opening the "man-hole" the steam burst forth in a volume, carrying the roof before it, and scalding to death the unfortunate workman.

Two other Boiler Explosions, attended with the loss of seven lives, have also occurred, namely, at the Brymney Iron Works, South Wales. The ends of one of the six large boilers came out without much noise, and the consequent rush of steam swept every thing in its range before it. At Deane Engine, Lumb (on the 8th inst.), by which three persons were killed and many more scalded, the boiler being hurled to a distance of forty or fifty yards.

The Huddersfield Steam-Boiler Association (formed principally for the prevention of explosions), in their last Report state that their inspecting engineer has examined 33 boilers internally, and 17 externally; 2 were reported dangerous, and 5 requiring repairs, from the corrosion of their plates.

MINES, METALLURGY, &c.

East India Copper.—At a meeting of the East India Copper Company, recently held in Calcutta, a slab of copper, smelted from the ores of the Company, was produced, and pronounced equal, if not superior, in quality to Japan.

Aluminium.—A workman at Florence has discovered a method of making aluminium in a much less expensive manner than has hitherto been known.

Gas-lights in Coal-pits.—It has recently been found safe and practicable, under proper precautions, to introduce gas-lights in coal mines. This has been done (it is said with success) at the High Elsecar Colliery, near Barnsley, the property of Earl Fitzwilliam, and *naked gas-lights* are now burning in all the board-gates and stables. After due trial, gas will be introduced into every part of the workings, and, where absolutely necessary, through the medium of the Davy lamp.

Our Metalliferous Products are valued at £35,000,000 a year.

Prevention of Mining Disasters.—In the Scottish mines a new system of prevention is in contemplation, including, as regards the present works, the establishment of "rooms of refuge" for the miners, to avoid the effects of the "after-damp" consequent on explosions.

Gold in the Indian Hills.—According to the "Lahore Chronicle," gold (in dust) is to be found in all the rivers of the Punjaub before they leave the lower ranges of the Himalaya. Practical gold-seekers are advised "to proceed to the hills, turn the course of one of these auriferous streams, and sink a shaft."

Coal.—From a recent Parliamentary return it appears, that 6,483,416 tons of coal were last year exported from the United Kingdom to foreign countries and British possessions abroad. In the same year 4,368,708 tons were brought to London, of which 3,133,459 tons were conveyed coastwise, and 1,235,249 tons by inland navigation and land carriage.

The Export of Metals Return, for last month, shows a decline from corresponding period of 1857. In pig iron the decline is general, with exception of an increased exportation to Holland. Cast iron improved, in consequence of a considerable increase in shipments to Australia, Canada, and United States. In wrought iron the only increase was to India. Steel shared in the decline. In copper (sheets and nails), an increase, due entirely to the demand from Australia. Shipments to all other parts of the world show a decline. In tin-plates, a diminution in demand from the principal consumers—viz., United States, Canada, and the Hanse Towns.

The Returns from the Burra-Burra Copper Mines, in South Australia, afford an instance of extraordinary development in mining industry. The first excavations were made in 1845 by twelve miners: now the number of miners exceeds 1,000. The ore hitherto dug has yielded 28,100 tons of copper.

A Colliery Explosion of Fire Damp has occurred in the Bryndyn Colliery (Messrs. Ford and Sons), near Pyle, Glamorganshire. Every man in the working killed—12 in number. Cause at present only conjectured.

Gun Metal.—The Government, on the request of Lord Brougham, has made a grant of old gun metal in aid of the completion of the Newton Monument at Grantham.

The New Great Bell for the Victoria Clock Tower (re-cast from the remains of "Big Ben") has been conveyed, in due pomp, from the foundry to the foot of the Clock Tower. It has been re-christened "Victoria."

The Australian Gold Exports for the present year have, according to the "Melbourne Herald" of the 15th inst., fallen off to the extent of 36,633 oz., as compared with corresponding period of last year; and as much as 194,748 oz. as compared with the first fourteen weeks of 1856. Chief cause assigned, want of capital to work the auriferous deposits.

Chemical Treatment of Auriferous Quartz.—Late advices from Australia announce the *sudden* death (on 24th March) of Count Dembinski, whose suggestion on the subject of the dissolution of auriferous quartz by common chemical agency (lately patented in this country), had particularly attracted the attention of the Australian public.

New Gold Fields in Washington Territory.—Official information has been communicated to the (American) Government, confirming the reports of gold discoveries in this district.

By the Fall of a Roof at the Masonfield Colliery, near Wolverhampton, three men have been killed on the spot, and several others seriously injured.

APPLIED CHEMISTRY, &c.

Deodorization of Sewage Water by Quicklime.—The Court of Queen's Bench has, in granting a new trial, negatived the direction of Mr. Justice Erle, in the late case of alleged infringement of patent right (Higgs *v.* the Hitchin Board of Health), by which the use of hydrate of lime, or "quicklime," in the deodorization and purification of sewage water, had been declared to be the subject of individual patent right.

New Material for Alcohol.—Messrs. Geutel have patented a method of manufacturing alcohol from asphodel roots.

Indelible and Indestructible Ink.—Mr. Joseph Ellis, of Brighton, recommends a solution of shellac with borax in water, and adding a suitable proportion of pure lampblack. The result is an ink alleged to be indestructible by time or by chemical agents, and which, on drying, will present a polished surface, as with the ink found on the Egyptian papyri.

Photographic Images on India-rubber.—A new medium for receiving photographic impressions has been invented in America, namely, common paper prepared with a solvent ("solution"?) of india-rubber. When ready for the sensitizing operation it is perfectly black on both sides, and of a shining appearance, not unlike a piece of japanned leather. Portraits on this new material are stated to have a peculiar softness and finish.

Photography on Ivory.—By Messrs. Beard and Sharpe's new process, patented in this country, the images are permanently fixed on ivory tablets. Portraits, &c., so produced are likewise said to possess a peculiar beauty of tone and harmony of light and shadow.

Electro-Galvanic Currents.—Mr. Holmes, of Glasgow, has invented a new mode of treating electric currents over long distances. The object is to avoid the difficulties hitherto attendant on this branch of galvano-electric manipulation.

NOTICES TO CORRESPONDENTS.

R. B. (Genoa.)—We cannot do better than give you the following extract from the Instructions for Correcting Iron Ships' Compasses at Sea, with Gray's Patent Apparatus, as approved of by the Astronomer Royal:—"After the binnacles and apparatus are applied by a competent person, observe, by a compass made especially for the purpose, and fixed on the mast at an elevation beyond the influence of the hull, when the ship's head is due north or south, or ascertain the same by azimuths or amplitudes. Turn the screw connected with the magnets fixed athwart ships until the compasses all stand due north or south, then put the ship's head due east or west, and turn the screw connected with the magnets placed fore and aft until the compasses stand due east or west. Should there be a small amount of deviation, previously ascertained and recorded, steer by that record. Should a change take place in the magnetic character of the ship in the southern hemisphere of an opposite character to the northern, all that has to be done is to reverse the magnets, and adjust as previously directed, taking care to keep the vessel as upright as possible. Afterwards, if it is discovered, when the vessel's head is due north or south, that a deviation exists from the heeling of the ship, screw the magnet placed vertically until the compass is correct; and should it be necessary in the southern hemisphere to change the position of the vertical magnet, it can be easily reversed. In steamships it is highly necessary that, during the time of observation and adjustment, the engines should be slowed or stopped, as vibration has a tendency to produce oscillation. *As to the mast-head compass.*—After the steering compasses are adjusted by the mast-head compass, it is imperative that the card should be unshipped, which is effected by turning the screw at the side of the bottom of the bowl; for, if allowed to be in perpetual action, the extreme motion above will destroy the perfect indication of the instrument." We regret we cannot give you any further description of Mr. Gray's apparatus, but have written to him for more particulars for you, which, if received, may be found in another part of this month's Artizan. Write to him in Liverpool.

R. C.—The steamer you refer to must be one named after our Journal—The Artizan. She is a screw steamer, and was built by Messrs. G. K. Stothert and Co., of Hotwells, Bristol. We believe the *Artizan* answers admirably. We will endeavour to obtain further particulars.

Q.—The vessel referred to is the *Japanese*. She has been built and fitted by Stillman and Allen, of the Novelty Iron Works, New York. We have the particulars of her, which will be given shortly.

M. T. (Long-alley.)—The slot link answers very well. A good long connecting rod is always advisable under the circumstance. There is no fear of the plan you mention ever superseding the ordinary principle.

J. Walliss.—We know many others who would be glad to take advantage of Mr. A.'s announcement, if it were true. The absurdity of supposing 1 lb. being equal to the duty of raising 4 lbs. in the same space and time is too absurd to entitle it to a moment's consideration. Most men have their foibles, and some men are fond of riding hobbies with which they are not thoroughly acquainted. The writer in question is really a talented man, and in all he has written there is much that is useful, although there may be some things likely to mislead but for their transparent fallaciousness.

D. (Hull.)—You had better address Messrs. Taylor and Lewis, of Birkenhead, upon the subject of Muntz's patent for paddle-wheels, recently noticed in The Artizan.

T.—We have not forgotten promises made by us. We have a great number of plates in progress, and some which have been completed and stood over for want of opportunity, but they will be given shortly.
JOHN HUGHES (Sunderland).—When found, the Number will be sent.
A. BUECY.—Be good enough to forward your address; the information shall be sent.
POWER.—We will give you Mr. Armstrong's address, as, perhaps, he can help you out of your difficulty. Send us your name and address.
EMPLOYER.—We think the idea a good one; and although we do not ourselves profess tectotalism, we think it would be a great advantage to mechanics if they would abstain from intemperance. You are, perhaps, not aware that there is already such an establishment as you propose. Having caused inquiry to be made, the address of the Registry Office is 32, Farringdon-street, City.
SALINOMETER.—There are two in ordinary use, How's and Spray's. The former we have used, but of the latter we know but little, and cannot inform you where they can be had.
J. C.—Ice-making by steam. We have seen the apparatus at work at No. 4, Red Lion-square, but we cannot express any opinion here as to its economy. Most of the ice we saw was opaque.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 15th March, 1858.

524. W. G. Taylor, Ashby-de-la-Zouch, Leicestershire—Preparing skins for tanning.

Dated 22nd March, 1858.

596. A. Lester, Coventry—Weaving ribbons, fringes, trimmings, &c.

Dated 9th April, 1858.

768. J. B. Biebuyck and J. Van Landuyt, Brussels—Process for separating the vinous and amylaceous principles from vegetable substances.

Dated 14th April, 1858.

804. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Obtaining motive power.

Dated 17th April, 1858.

834. Grassay, Ivry, Rue du Chevaleret, 7, Paris (Seine)—Hangings and all sorts of papers made waterproof by a new process.

Dated 20th April, 1858.

860. E. Derogy, 33, Quai de l'Horloge, Paris—Instruments and apparatus applicable to photographic purposes.

Dated 22nd April, 1858.

880. W. Bishop, Boston, Lincolnshire—Machinery for ticketing or labelling spools, bobbins, or reels; for adjusting the size thereof for sampling patterns; for printing labels or tickets, affixing postage or other stamps or labels, for cutting their edges, and dividing them into given quantities and sizes.
883. J. Chatterton, 7, Devonshire-st., Islington—Combining and coating insulated metal conductors for electric telegraphs.

Dated 23rd April, 1858.

896. W. Ryder, Bolton-le-Moors, Lancashire—Preparing moulds and moulding-boxes for casting metal or other materials.

Dated 24th April, 1858.

904. A. S. Stocker, 18, Wimpole-st., Cavendish-sq.—Articles to be affixed to boots and shoes, and to the feet of animals.
906. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A moderator piston.

Dated 26th April, 1858.

918. W. A. Martin, 16, Powis-st., Woolwich—Shoe scraper.

Dated 27th April, 1858.

938. D. E. Hughes, New York, U.S.—Apparatus for transmitting signals and electric currents.

Dated 28th April, 1858.

948. L. Tapié, Bordeaux (France)—Shipbuilding.

Dated 29th April, 1858.

958. W. Smith, 18, Salisbury-st., Adelphi—Steam ploughs. (A com.)

Dated 30th April, 1858.

964. B. L. A. Peaucellier, Paris, Boulevard Bonne Nouvelle, No. 10—Plough.

Dated 3rd May, 1858.

981. J. A. Hartmann, Mulhouse, France—Preparing colors for printing cotton cloth.
983. S. Etchells and A. Consterdine, Nottingham, and S. Cattell, Radford—A reversing water tube iron, to work with single blast or double blast.
985. J. Taylor, Roupell-park, Streatham-hill, Surrey—Stoves and fireplaces.
987. W. Clark, 53, Chancery-la.—Separating, and in otherwise treating matters in a state of fusion.

Dated 4th May, 1858.

989. J. Swain, Hyde, and M. Swain, Dukinfield, Chester—Metallic pistons.
990. W. H. Morrison, Nottingham—Apparatus employed in the manufacture of bonnet and cap fronts, rouches, and such like articles of millinery.
991. H. L. Mcall, 3, St. Matthew's-pl., Hackney-rd.—Spring fastenings, suitable to be used for dresses, brooches, &c.

Dated 5th May, 1858.

993. D. Thom and G. Phillips, Pendletoo, Lancashire—Apparatus for bleaching and raising oil and fat.
994. R. Sharp, Lowther-st., Liverpool—Pianofortes.
995. W. Ross, Glasgow—Taps or valves.
996. C. D. Archibald, Rusland Hall, Lancashire—Improved mode of treating air and gases, and applying the same for purposes of motive force.
997. J. H. Johnson, 47, Lincoln's-inn-fields—Signal and indicating apparatus for railways.
998. T. Preston, Nottingham—Manufacture of cut pile fabrics, in warp machines.
[9]99. W. S. Hollands, 5, Anchor-ter., Mawbey-rd., Old Kent-rd.—Extracting and purifying oils and fatty matters.
1000. J. Lawson and T. Robinson, Leeds—Machinery for hackling and dressing flax.
1001. T. Holstead, Carlisle—Machinery for the manufacture of certain articles of confectionary.
1002. D. E. Hughes, New York—Apparatus for transmitting signals and electric currents.

Dated 6th May, 1858.

1003. J. Richards, Moorgate-st.—Rotary pumps.
1004. M. Davis, 5, Lyon's-inn—Carriage wheels.
1005. J. S. Willway, Bristol—Apparatuses for ringing bells.
1006. J. Whitley, Leeds—Manufacture of iron.
1007. W. Heap, Oldham-road Tool Works, Ashton-under-Lyne—Pipe joints or couplings.
1008. E. J. Scott, Glasgow—Boots and shoes.
1009. H. Ashworth, Prestwich, Lancashire—Apparatus for cutting hides or skins.
1010. T. W. Thacker, Derby—Construction of the finger-ends of pianoforte, organ, and harmonium keys.
1011. J. Bridgman, Hamburgh—Imp. in cooling fluids.
1012. J. Casey and J. Hughes, Spital-sq.—Looms for weaving velvet ribbons.
1013. W. E. Newton, 66, Chancery-la.—Manufacture of saltpetre.
1014. W. Clark, 53, Chancery-la.—"Bitts," for horses' bridles.
1015. J. Wright, 10, Alfred-pl., Newington-causeway, Southwark—Imp. in treating madder for printing and dyeing.
1016. H. Jackson, 2, Park-st., Leeds—Machinery for dressing and cleaning flax, hemp, &c.
1017. W. Willis, W. Langford, and J. Slack, Nottingham—Pressure guages.

Dated 7th May, 1858.

1018. J. Bunnett and J. G. Bunnett, Deptford—Steam-engines.
1019. C. J. Carr, Wentworth, Yorkshire—Forge and other hammers.
1020. J. Castle, Grantham—Breaks used for retarding the motion of carriages on ordinary roads.
1021. R. Openshaw, Firwood, near Bolton-le-Moors, Lancashire—Machinery for plating down or folding and measuring fabrics.
1023. J. M. Duvard, Luc-sur-Mer, Calvados, France—Bedroom vase.
1024. J. J. Field, Paddington—Extracting moisture from liquids, and from substances in a liquid state.
1025. A. Neilson, Glasgow—Boots, shoes, and other coverings for the feet.
1026. W. E. Newton, 66, Chancery-la.—Construction of fire grates for furnaces, stoves, and other fireplaces.
1027. G. B. Coggan, 108, Friar-gate, Derby—Apparatus to be called a stereoscopia, for exhibiting stereoscopic pictures.
1028. C. Botten, jun., Clerkenwell, and N. F. Taylor, Stratford—Apparatus employed in measuring and in regulating the flow of gas and other fluids.
1029. R. Best, Birmingham—Imps. in illumination.
1030. T. Brown, Ebbw Vale, and D. Brown, Cwmbrân, Monmouthshire—Machinery for filing or smoothing the ends of fish-plates, rails, and wrought-iron railway chairs.
1031. D. Stothard, Lambeth, J. Jones, Southwark, and D. Jonas and B. W. Jonas, Spitalfields—Improved ships' block.
1032. W. Clark, 53, Chancery-la.—Apparatus for sharpening saws.

Dated 8th May, 1858.

1033. J. T. Robson, 45, Hugh-st., West Pimlico—Sheet flue and tubular boilers.
1034. A. V. Newton, 66, Chancery-la.—Machinery for manufacturing paper.
1035. W. E. Newton, 66, Chancery-la.—Grinding circular saws.
1036. A. V. Newton, 66, Chancery-lane—Manufacture of hard and waterproof fabric, and the application of the same to the construction of boats, parts of carriages, and of furniture, portmanteaus, and travelling cases, and vessels of capacity.
1037. G. Day, St. Pancras—Self-acting valve for regulating the flow of liquids.

Dated 10th May, 1858.

1038. R. B. Goldsworthy, Manchester—Machinery for grinding emery and other materials.
1039. C. F. Vasserot, 45, Essex-st., Strand—Manufacture of umbrellas and parasols.
1041. W. H. Ogden, Liverpool—Pumps.
1042. W. C. Forster, 6, Great Tower-st.—Manufacture of bricks and slabs for preventing damp in the walls of houses and other buildings.
1043. I. L. Bell, Washington Chemical Works, Newcastle-upon-Tyne—Manufacture of iron.
1044. J. M. E. Masson, Rue des Fosses, St. Thomas, at Evreux (Eure), France—Diving apparatus.
1045. R. Willan and D. Mills, Blackburn—Apparatus for drawing in, twisting, or looming textile materials.
1046. W. G. Taylor, Ashby-de-la-Zouch, Leicestershire—Covering the rollers employed in spinning cotton and other fibrous materials.
1047. J. B. Pim, Newington Butts, and C. Payne, Bermondsey-st.—Recovering useful matters from oil or floor cloth, tarpaulin, American leather cloth, &c.

Dated 11th May, 1858.

1048. P. Apparuti, Paris, Rue Constantine, 24—A machine applicable for picking and choosing out corn.
1049. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Washing apparatus for iron ore and other matters.
1050. G. H. Creswell, Devonport—Pads and apparatus for inking stamps.
1051. J. H. Johnson, 47, Lincoln's-inn-fields—Madder dyeing.
1052. E. Fairburn, Kirklees Mills, Mirfield, Yorkshire—Apparatus employed in carding wool and other fibrous substances.
1053. J. Soutter, Hoxton—Washing machines.
1054. W. Pare, Seville Iron Works, Dublin—Metallic and other bedsteads.
1055. A. Parkes, Birmingham—Manufacture of tubes and cylinders.
1056. A. Parkes, Birmingham—Cylinders used for printing and embossing.
1057. W. Oliver, Cradley, Worcestershire—Combining ovens for the manufacture of coke with the furnaces of steam boilers.
1058. R. Halliwell, Bolton-le-Moors, Lancashire—Mules for spinning and doubling cotton and other fibrous materials.
1059. G. Lowry, Salford—Machinery for heckling flax.
1060. J. M. Gilbert, Manchester—Construction of cylinders and maundrils used in printing calico.
1061. J. Dyson, E. W. Shirt, and H. Shirt, Sheffield—Mode of rolling strips of steel for crinoline.

Dated 12th May, 1858.

1062. J. Henderson, Glasgow—Apparatus for measuring fluids.
1063. L. Durand, Marseilles—Tubular steam generator.
1064. M. Diosy, 123, Fenchurch-st.—Machinery for preparing or manufacturing granulated potatoes for preservation.
1065. J. A. Détroyat, 10, Rue de Choiseul, and F. Teubert, 18, Rue de Choiseul, Paris—Apparatus for cleansing hair combs.
1066. J. A. Clarke, Liverpool—Composition for coating vessels' bottoms.
1067. W. Mark, Stockton-on-Tees, Durham—Roofing.
1068. J. West, 234, Shales Moor, Sheffield—Covering and securing water taps and branches.
1069. A. H. Rogers, Fairfield, Manchester—Lubricators.
1070. J. Sharples, Crawshaw Booth, near Rawtenstall—Extracting moisture from and drying porous and fibrous substances.
1071. E. Knight, Foster-la., Cheapside—Apparatus for refrigerating, also for bottling aerated liquids.
1072. J. G. Jackson, Belper, Derby—Carrying roads over (or through) land covered with water.
1073. J. Biggs, Norton Folgate—Apparatus for compressing vegetable and other substances.
1074. A. L. Liétout, Paris—Portable medical and hygienic gymnastic apparatus.
1075. J. S. Bailey and W. H. Bailey, Keighley, Yorkshire—Machinery for preparing and combing wool, cotton, &c.
1076. J. Hamilton, Belfast—Preparation and use of starch for manufacturing, bleaching, and finishing purposes.

Dated 13th May, 1858.

1077. W. Simons, Glasgow—Construction of iron ships or vessels.
1078. R. Hislop, jun., Preston Pans, Haddington, N.B.—Apparatus for dressing or cleansing and separating grain and seeds.
1079. A. M. Dix, Hanley, Staffordshire—Process of brewing or obtaining decoctions.
1080. F. A. Deliry, Soissons, France—Mechanical kneading trough.
1081. A. Wolff, Paris—Musical instruments.
1082. H. Hyde, Truro, Nova Scotia—Improved apparatus for manufacturing oils.
1083. J. Gardner, Banbury—Chaff-cutting machines.

Dated 14th May, 1858.

1084. F. Warren, Birmingham—Construction of stands for telescopes and other instruments.
1085. J. Colgate, 56, Exmouth-st.—A "pipe case handle" for walking sticks, canes, riding whips, and umbrellas.
1086. S. Carpenter, Flushing, U. S.—Escapements for watches.
1087. D. Dick, 55, George-st., Paisley—Cushions for trusses.
1088. W. E. Newton, 66, Chancery-la.—Construction of lamps.
1089. G. F. Chantrell, Liverpool—Waterproof lithic paint.
1090. J. Macintosh, North Bank, Regent's-park—Insulating telegraph wires.

1091. L. Petre, Hatton-garden—Application of glass to ornamental and useful purposes.

Dated 17th May, 1858.

1092. J. H. Johnson, 47, Lincoln's-inn-fields—Construcion of artificial legs and feet.
1093. D. W. Hayden, 75, Pratt-st., Camden-town—Boilers for agricultural or domestic purposes.
1094. J. Allen and W. Allen, Wallsend, Northumberland—Treatment of iron and copper pyrites.
1095. E. Tombs, 4, Waterloo-ter., Islington—Manufacture of ruche and other trimmings for ladies' apparel.
1096. J. Wittenberg, Cambridge-villas, Notting-hill—Motive power engines actuated by air.
1097. W. H. Bagnall, Masbro', Yorkshire—Stove grates.
1098. W. Raymond, Dalston—Life rafts.
1099. C. W. Harrison, Woolwich—Obtaining light by electricity.
1100. S. Hiler, Havestraw, U.S.—Method of coating or amalgamating iron with silver, copper, brass, or other metals, or alloys of metals.
1101. H. Curzon, jun., Kidderminster—Preparing printed yarns.
1102. S. Higgs, jun., Penzance—Precipitating copper from water having it in solution.
1103. R. Imeary, Gateshead, and T. Richardson, Newcastle-on-Tyne—Roasting small or disintegrated pyrites.

Dated 18th May, 1858.

1104. W. J. Hixon, 8, Victoria-grove-ter., Bayswater—Construction of reaping and mowing machines, and in the form or shape of the knive or knives to be used in connection therewith.
1105. J. Higgins, Oldham—Preventing explosions in mines, and in the machinery or apparatus employed therein.
1106. J. Mallison, jun., Bolton-le-Moors—Apparatus for dyeing yarns.
1107. A. A. Croll, Coleman-st.—Treatment of sulphate of alumina, and in obtaining alum.
1108. E. C. Brochand, Gerrard-st.—A travelling mill and improved millstones.
1109. S. Higgs, jun., Penzance, Cornwall—Miners' safety lamps.

Dated 19th May, 1858.

1110. G. M. Casentini, 24, Hercules-buildings, Lambeth—The manufacture of a solution for mixing with or guaging plaster of Paris (or any plaster having sulphate of lime or any similar substance for its base), so has to produce a hardened dense composition, the hardening or setting whereof may be retarded and regulated by the person using the same.
1111. J. Brown, Smethwick, Staffordshire—Manufacture of iron, and in rolling iron and steel.
1113. W. MacNaught, Manchester, and W. R. Critchley, Salford—Manufacture of copper or other metallic rollers or cylinders for printing fabrics.
1114. J. Maudslay, Lambeth—Manufacture of iron and furnaces.
1115. J. Bottomley and A. H. Martin, North Brierley, near Bradford—Apparatus employed in weaving.
1116. G. M. Miller, Great Southern and Western Railway—Joints of bridge rails for railways.
1117. C. M. Kernot, M.D., Gloucester-house, West Cowes, Isle of Wight—Distilling shale, boghead, and other mineral matters.
1118. W. E. Newton, 66, Chancery-lane—Applicable to certain descriptions of marine engines, and in the mode of mounting paddle-wheel shafts.
1119. W. F. Snowden, Longford, Gloucestershire—Construction of chaff and litter cutting machine.
1120. W. Clark, 53, Chancery-lane—Manufacturing knotted webs or nets.
1121. M. Henry, 84, Fleet-st.—Apparatus for communicating, or transmitting, or producing fac-simile copies of dispatches, intelligence, or message, or characters, drawings, or devices.

Dated 20th May, 1858.

1122. J. Hesford, Bolton-le-Moors, Lancashire—Construction of stretching machines for cotton.
1123. M. Brun, Vienne (France)—Dyeing.
1124. A. F. Cossus, Cagliari, Sardinia—Treating oils and fatty matters.
1125. H. Brierly, Manchester—Mules for spinning.
1126. J. Copcutt, 5, Park-pl., Newland-st., Kensington—Preparing materials employed to obtain light when using oxygen and hydrogen gases.
1127. J. Boydell, 65, Gloucester-crescent, Camden-town—Machinery for propelling vessels.
1128. R. A. Brooman, 166, Fleet-st.—Apparatus for purifying sulphuret of carbon.

Dated 21st May, 1858.

1129. T. Settle, Bolton-le-Moors, Lancashire—Apparatus for preparing, slubbing and roving cotton and other fibrous materials.
1130. J. C. Brant, Surrey-sq., Old Kent-rd.—Permanent way of railways.
1131. F. C. Bakewell, 6, Haverstock-ter., Hampstead—Machinery for making bolts.
1132. M. Henry, 84, Fleet-st.—Manufacture or preparation of ink and paper, to adapt them for copying purposes, in preserving food, skins, and hides, in rendering lint, vesicatory paper, and textile fabrics absorbent, and in treating mortar, cement, and other matters, in order to keep them in a damp state.
1133. J. Adamson, St. John-st.-rd.—Manufacture of parts of gas meters.
1134. G. F. Muntz, French-walls, near Birmingham—Preparing yellow metal sheathing.
1135. J. Apperly and W. Clissold, Dudbridge—Machinery for condensing wool and other fibrous substances.
1136. S. Bryer, St. George's-ter. Cheltenham—Instruments to be used in the sensitizing and developing of photographic plates.
1137. J. Sholl, Victoria-grove-west, Stoke Newington—Manufacture of paper used for letter-press, lithographic, and copper-plate printing, and for other purposes.

Daetd 22nd May, 1858.

1139. J. Elce and J. Champion, Manchester—Machinery used in preparing and spinning cotton and other fibrous substances.
1140. P. Féron, Theuville-aux-Maillots, France—Bandage or truss.
1141. J. Ronald, Liverpool—Dressing hemp, flax, and other fibrous materials.
1142. E. T. Hughes, 123, Chancery-lane—Apparatus for embroidering.
1143. E. T. Hughes, 123, Chancery-la.—Apparatus serving the purposes both of saponification and of decomposing neutral fatty substances into fatty or oily acid and glycerine.
1144. J. Foot, Spital-sq.—Manufacture of fringes.
1145. F. G. Underhay, Wells-st., Gray's-inn-rd., and J. L. Clark, Haverstock-hill, Hampstead—Cocks or taps, and in apparatus for flushing.
1146. T. S. Cressey, High-st., Homerton—Apparatus for calculating wages.
1147. J. H. Johnson, 47, Lincoln's-inn-fields—Curtain rods.
1148. A. P. Price, Margate—Treatment and smelting of certain argentiferous or silver ores.
1149. A. P. Price, Margate—Treatment of certain zinc ores and compounds of zinc, and in the manufacture of zinc and oxide of zinc.
1150. I. Baggs, Doddington-grove, Kensington—Electric telegraphs.
1151. A. Ellissen, Throgmorton-st.—Signalling in railway trains.
1153. G. F. Parke, Lower Smith-st., Clerkenwell, and J. Briant, Curtain-rd.—Bonnets.
1154. W. Clark, 53, Chancery-lane—Apparatus for moulding articles of cement.

Dated 24th May, 1858.

1155. R. L. Hattersley, Keighley, Yorkshire—Looms for weaving.
1157. M. Stevens, Holywell, Flintshire—Machinery for pulping straw and other vegetable fibres.
1158. J. Scholfield and W. Cudworth, Rochdale—Apparatus for preparing, doubling, and twisting cotton.
1159. G. White, 34, Dowgate-hill—A liquor suitable for manufacturing beverages, and for culinary purposes.
1159. W. Harding, Forest-hill, Kent—Revolver fire-arms.
1160. G. Hamilton, St. Martin's-le-Grand, and W. H. Nash, Poplar—Locks and keys.

Dated 25th May, 1858.

1161. Prince A. Galitzin and S. Souschkoff, Paris, Boulevart de Strasbourg, 60, and P. E. Guérinot, Paris—Apparatus to prevent boats or ships to be destroyed and sunk when running full against each other.
1162. J. A. Phillips, Earl's Court-ter., Kensington—Production of zinc, lead, copper, and silver, from ores containing these metals.
1163. W. Webster, Washington, U.S.—Machinery for the propulsion of vessels.
1164. G. W. Morse, Baton Rouge, Louisiana, U.S.—Fire-arms and cartridges.
1165. W. Webster, Washington, U.S.—Method of rigging vessels.
1166. C. F. D. Monuin, 26, Rue Vendome, Paris—Manufacture of rivets, screws, spikes, pins, and nails.
1167. C. F. Vasserot, 45, Essex-st., Strand—Construction of rails for fences and gates.
1169. G. Alton and J. Fernie, Derby—Construction of steam-boilers and other vessels capable of resisting pressure, and the manufacture of plates for the same.
1170. J. F. Belleville, Paris—An apparatus for indicating the work of pumps.
1171. J. Courage, Horsleydown—Furnaces for smelting and calcining.
1172. W. E. Newton, 66, Chancery-la.—Breech-loading fire-arms and cartridges.
1173. R. C. Witty, Mitcham, Surrey—Protecting ships of war and land batteries and fortifications from injury from shot and other projectiles.

Dated 26th May, 1858.

1174. F. A. Gatty, Accrington—Treating cotton or cotton yarns and fabrics when dyed with certain colours.
1175. R. H. Nicholls, 42, St. Michael's-hill, Bristol—Taps
1176. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Apparatus for baking firebrick clay.
1177. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A distilling pipe.
1179. J. Luis, 1B, Welbeck-st., Cavendish-sq.—The application and use of the fibrous textile plant called in Arabia, "diss," or in Latin, "arundo festuca patula," or by botanists, "festu coides et donax tenax," in the manufacturing of pulp for paper, and tow for thread, tissues, and cordage.
1180. J. C. Riddel, Belfast, D. Ritchie, A. Watson, and J. F. Allan, Glasgow—Cooking ranges and fire-places, or cocks for drawing off ale or other liquids.
1181. C. Cheadle, Wolverhampton—Improved flooring cramp.
1182. W. Bayliss, Wolverhampton—Iron tubular fencing, to be used for general fencing.
1183. W. Cowan, Edinburgh—Apparatus for disengaging horses from carriages in case of accident.
1184. P. A. Fourgassié, Castres, France—Apparatus for clod crushing, rolling, weeding, and scarifying.
1185. M. Henry, 84, Fleet-st.—Improved fabric and improved sewing and stitching machine, especially applicable for manufacturing the same.
1186. S. C. Lister, Bradford, and J. Warburton, Addingham—Spinning.
1187. J. Stuart, Sly Kate's-hill, Chatham—Distilling asphalte, pitch, tar, and other bituminous substances.
1188. F. Bouquié, Paris—Manufacture of chains.

Dated 27th May, 1858.

1189. A. C. Engert, City-rd.—Preparing tin foil or leaf in order to its employment as a substitute for silver leaf.
1190. J. Schofield, Rashcliffe, Lockwood, near Huddersfield, and G. Harling, Primrose-hill, in Aldmondbury, Yorkshire—Weaving.
1191. C. Cuit and A. Godefrey, Paris—Railway breaks.
1193. C. Cowper, 20, Southampton-buildings, Chancery-lane—Machinery for combing and preparing wool and cotton.
1194. G. H. Bovill, Durnsford-lodge, Wimbledon, Surrey—Manufacture of fuel.
1195. V. L. Vodoz, Westminster Club, Albemarle-st.—Chimneys and glasses of gas and other lamps.
1196. C. Clarke, Newmarket Union House, Exning, Suffolk—Machinery for dibbling wheat.
1197. J. Bower, Hunslet, near Leeds—Manufacture of glass.

Dated 28th May, 1858.

1198. S. Osler, South Quay, Great Yarmouth, Norfolk—Manufacture of fish into guano and food.
1199. C. Stanley and J. Fittall, Birmingham—Skylights and glass roofing.
1200. T. W. Dunn and W. Irlam, Manchester—Machinery for altering the position of locomotive engines and carriages on railways.
1201. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Key-joint for connecting detached pieces of wood or metal.
1202. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—An aperient biscuit.
1203. L. Tindall, Sherwood Foundry, Mansfield—Apparatus for sweeping and cleansing roads and streets.
1204. J. F. Lackersteen, Young-st., Kensington—Machinery for cutting and splitting wood.
1205. A. Godet, 31, Rue St. Hubert, Bordeaux, France—Raising weights.
1206. A. Arnal, Due du Faubourg, St. Honoré, No. 191, Paris—A nose bag for horses.
1207. E. Bond, Wharf-rd. City-rd.—Aerated liquid.

Dated 29th May, 1858.

1209. E. Sykes, R. Sykes, and P. Sykes, Huddersfield—Continuous spinning and roving machines for spinning and roving wool
1211. A. Dold, Chatham—Apparatus for winding clocks, which apparatus is also applicable as a motor for all machinery usually turned by hand, horse, or other power.
1213. J. Martin, Newman-st., Oxford-st.—Apparatus for the prevention or cure of smoky chimneys.
1215. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Fumigating apparatus.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

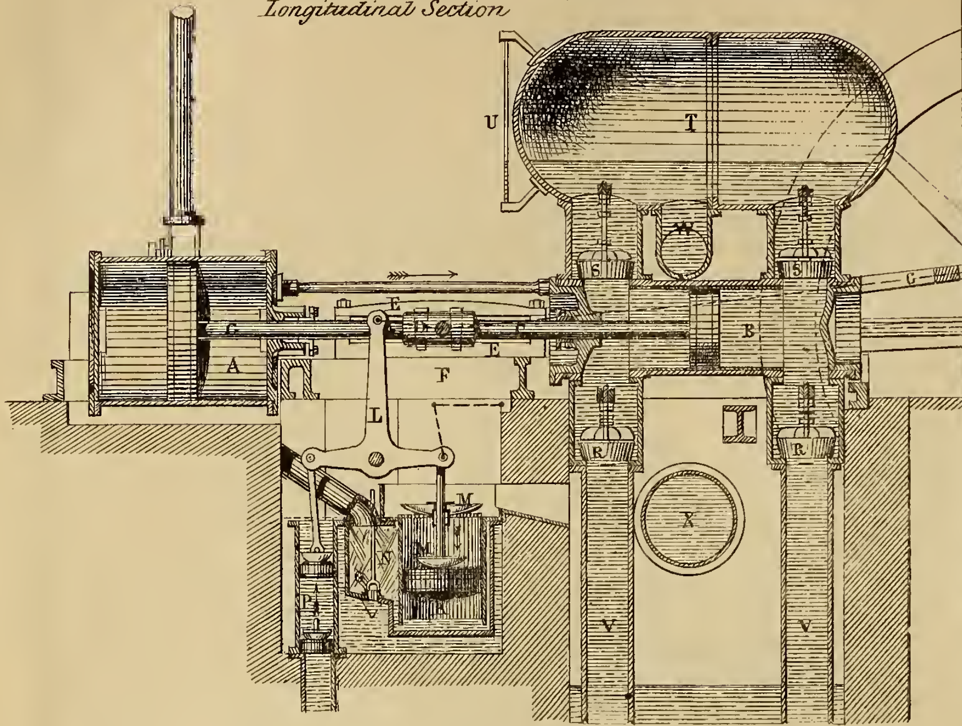
1326. L. A. Bigelow, 133, High Holborn—Sewing-machines. 11th June, 1858.
1333. G. T. Bousfield, Loughborough-park, Brixton—Marine steam engines.—11th June, 1858.
1348. C. C. J. Guffroy, Lille, France—New smoke-consuming apparatus.—15th June, 1858.
1264. J. H. Johnson, 47, Lincoln's-inn-fields—Railway wheels, and axle-boxes and bearings for the same.

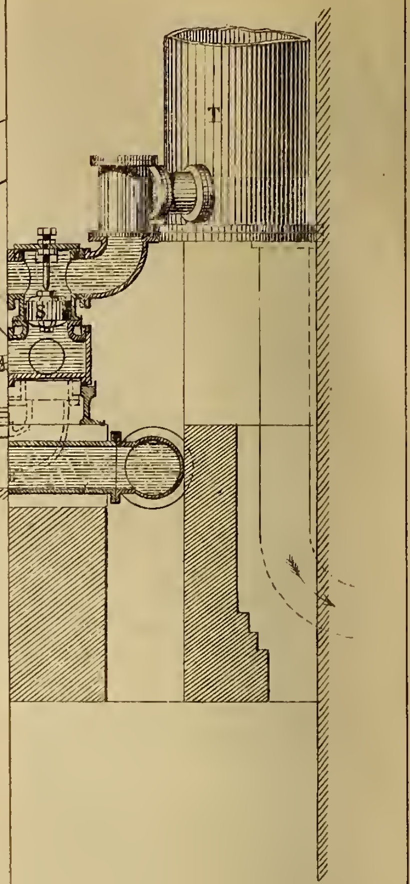
DESIGNS FOR ARTICLES OF UTILITY.

4090. May 21. N. McCann, 378, Euston-rd.—"Portmanteau Trunk or Box."
4091. „ 22. T. G. Messenger, Loughborough—"Deep Well Pump."
4092. „ 25. J. Oxley, Camden Town—"The Multum-in-Parvo Bath."
4093. June 2. J. Clayton, Wolverhampton—"A Furnace for Smelting and Refining Iron."
4094. „ 4. McIntyre, Hogg, and Co., 26, Addle-st., Wood-st., London—"The Epaulette or Double-shouldered Shirt."
4095. „ 2. M. Phineas, 42, Bold-st., Liverpool—"Ink-stand."
4096. „ 10. J. Jaques, 102, Hatton-garden—"Portable Backgammon, Chess, and Draught Board."
4097. „ 10. S. Cartwright and R. Ryall, Louth, Lincolnshire—"Tubular or Pipe Steam Boiler."
4098. „ 15. J. Morris and Sons, Astwood Bank, near Redditch—"Needlecase or Pincushion."
4099. „ 17. J. F. Elwall, 1, Albert-ter., Royal-rd., S.—"A Stay Fastening or Busk."
4100. „ 18. Fowler and Fry, Temple Gate Factory, Bristo—"Improved Tumbler Cart."
4101. „ 23. E. Russell, 87, Holborn-hill—"The Perfect Union Joint."
4102. „ 23. W. Wilson, 50, King-st., Manchester—"A Hot Water Cistern for Domestic Purposes."

HOR

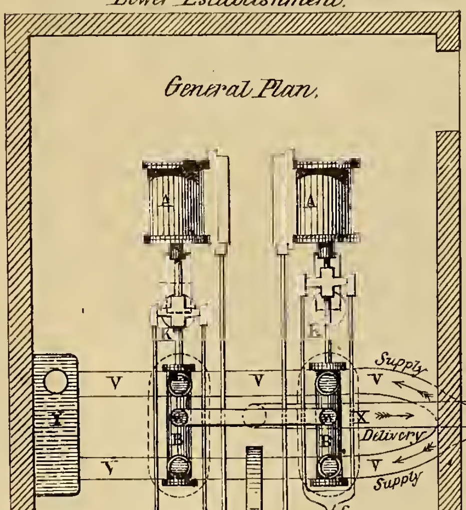
Fig. 1.
Crystal Palace Pumping Engines.
Longitudinal Section





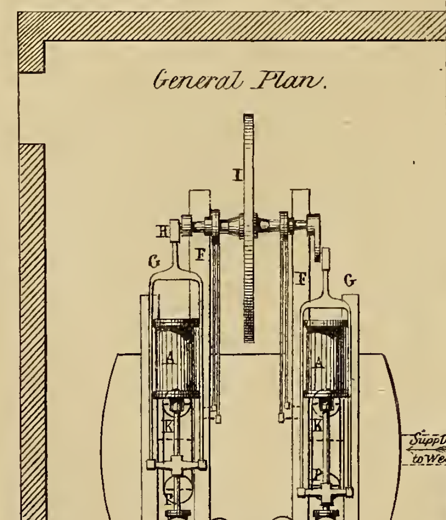
Scale to Figs. 1 & 2.
12 6 0 1 2 3 4 5 10 ft.

Fig. 3.
Crystal Palace Pumping Engines.
Lower Establishment.

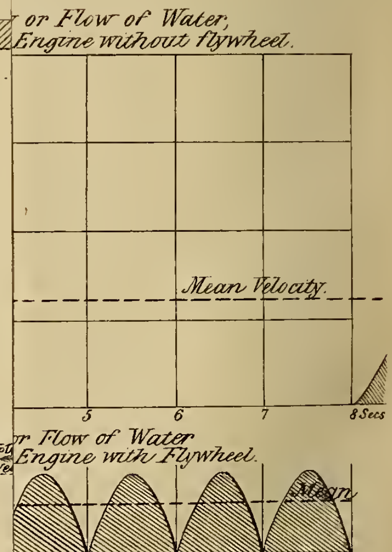


5 0 5 10 15 20 FT

Fig. 5.
Yarmouth Water Works Engines.

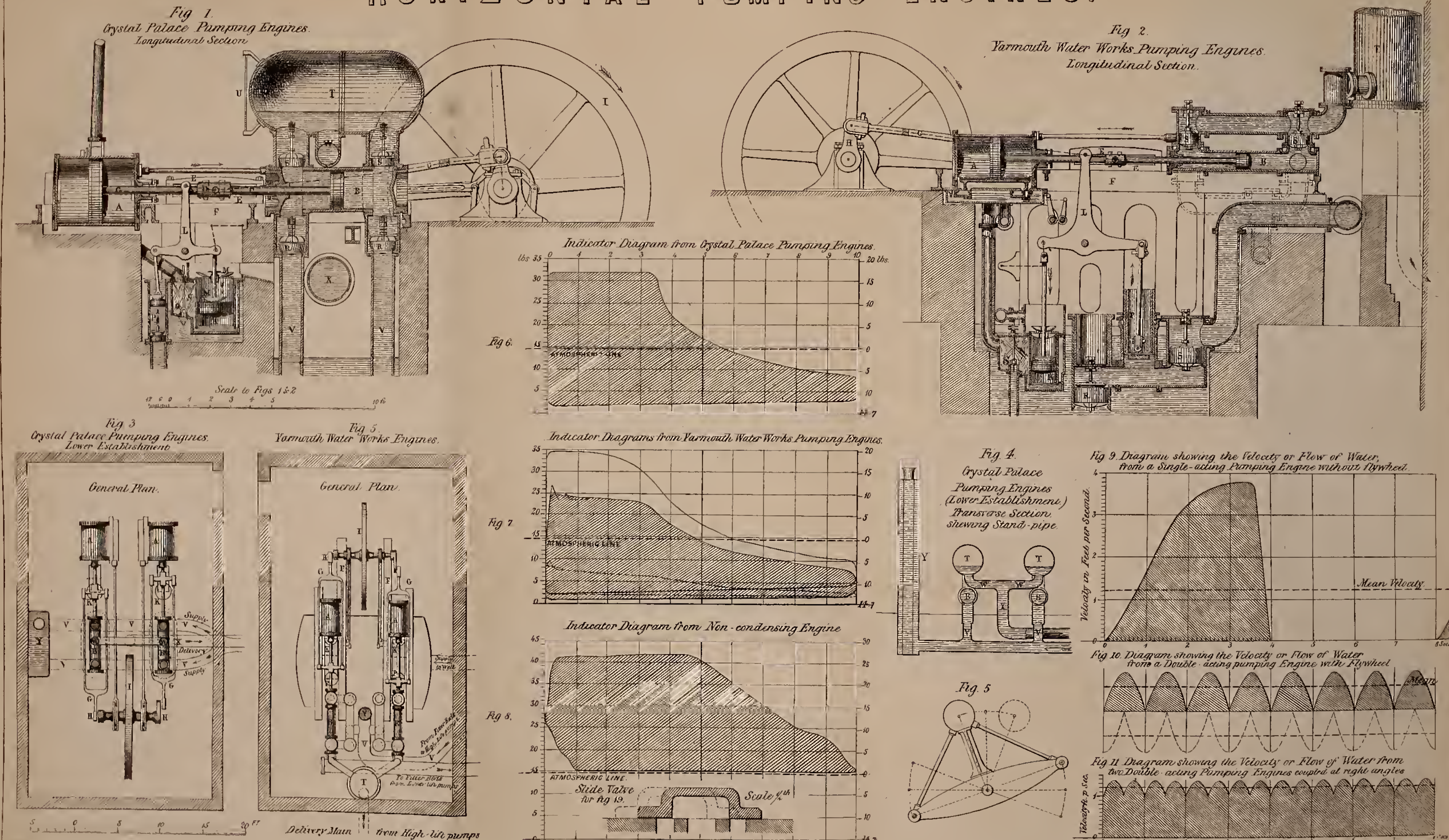


Delivery Main from High-lift p

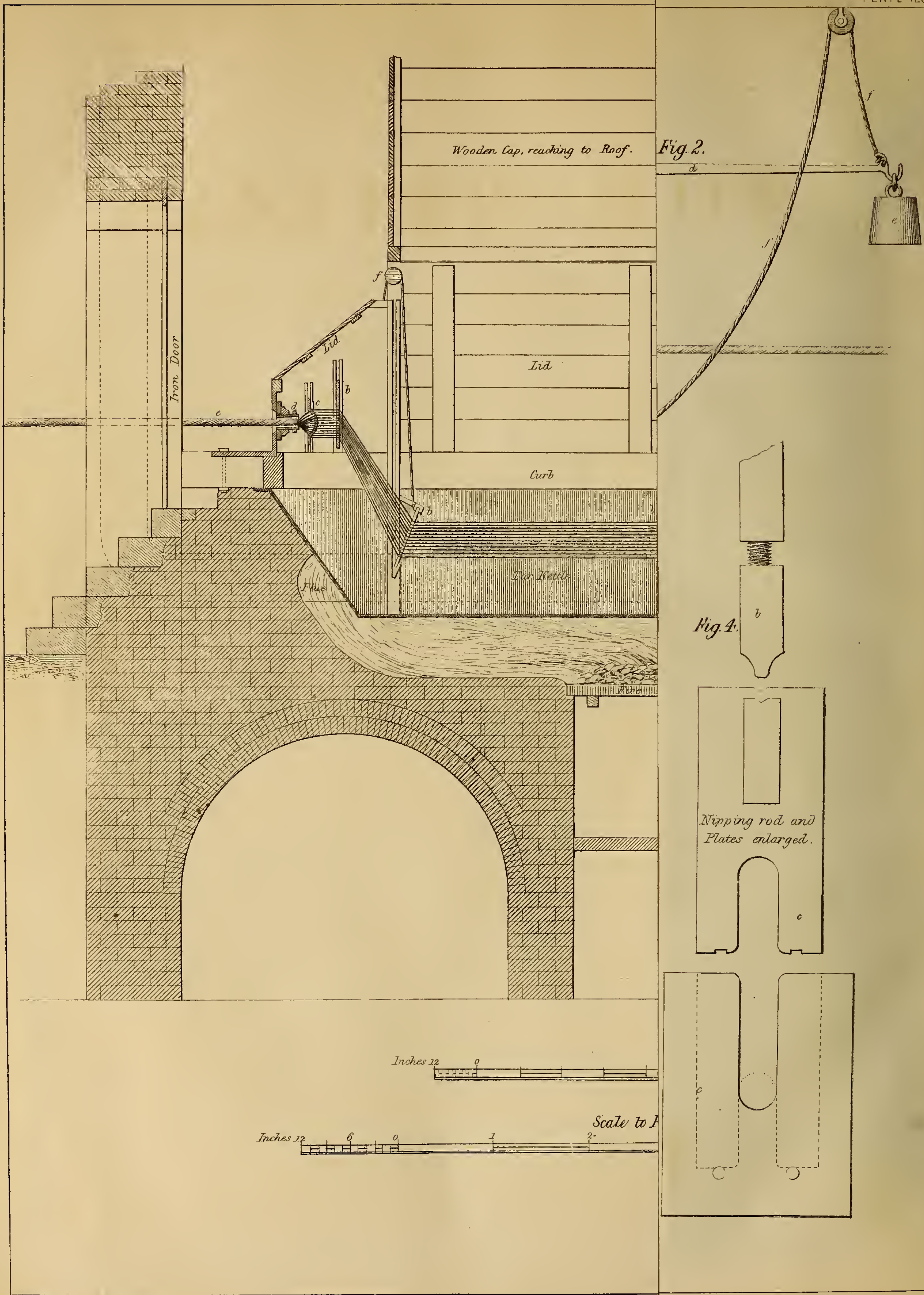


W. Smith, C.E. direx.

HORIZONTAL PUMPING ENGINES.



A Smith, C.E. direx.



W. Smith C.E. direx.

THE ARTIZAN.

No. CLXXXVII.—Vol. XVI.—AUGUST 1st, 1858.

THE EASTERN STEAM NAVIGATION COMPANY'S GREAT SHIP AND THE ATLANTIC TELEGRAPH CABLE.

In the "Times" of July 6th, a leading article is devoted to the subject of want of success which attended the last attempt to submerge the Atlantic Telegraph cable. The article in question was penned immediately after the arrival of the *Niagara*, and before the *Agamemnon* had returned. The writer of the article commences by stating, "All will be disappointed, very few surprised, to hear the failure of the second attempt to bind together with the electric cord the New and Old World. We don't know how it struck the scientific people, or the bulk of our readers, but we will confess to very scant encouragement from the report of the preliminary experiments." These are very strong and unwarranted assumptions, and are evidently penned by some one who, without the ability to form a competent judgment of the scientific part of the question, has undertaken to write a leader upon the subject, and lay bare his shallowness. It has been said "that any fool can find fault," and this quality the writer of the leading article of the 6th of July appears to possess in an eminent degree; but in addition thereto, he possesses another quality which renders him exceedingly useful to his employers, for no doubt he has on other occasions been more fortunate in following his propensity for appropriating the suggestions of others, as also in concealing his ignorance of the details of the subject upon which he has undertaken to write. Possibly they have passed unobserved, or have not been thought worthy of correction.

The following extract is from the "Times" of 6th July, and is that to which we refer and desire to draw the attention of our readers :—

A suggestion has been made several times in these columns, and seems to us worth considering. The *Leviathan* is as yet only a shell. Excepting that it has not even its engines on board, it is exactly in that state to which, at great difficulty and cost, the *Agamemnon* and *Niagara* have been reduced for this service.

Now this paragraph begins with a falsehood, is followed by a mis-statement, and ends with a gross exhibition of ignorance respecting the subject upon which he is writing; indeed, the whole is a mass of ignorance and untruth, and a gross attempt, on the part of the writer thereof, to appropriate the idea there suggested, as his own. To employ the mildest terms to such statement, it is certainly a mis-statement made to induce the belief that the idea of employing the *Great Eastern* for submerging the Atlantic Telegraph Cable was first made in the columns of the "Times," and inferentially that such proposition was made by the writer of the said article. Now to this appropriation of idea we are not disposed quietly to submit; for although the writer of the several notices of the *Great Eastern* which appeared in the "Times," obtained from The Artizan *alone* (copies of which he had for the express purpose) all the dimensions and particulars upon which he based his notices, and *literally copied sentence after sentence from our columns without the slightest acknowledgment*, the present case is one we cannot suffer to pass unnoticed.

THE FOLLOWING IS AN EXTRACT FROM "THE ARTIZAN" OF OCTOBER 1st, 1856.

THE EASTERN STEAM NAVIGATION COMPANY'S GREAT SHIP, WITH A SUGGESTION FOR ITS FIRST EMPLOYMENT.

We have a suggestion which has occurred to us, and which we desire to make to the proprietors of the great ship, and we believe it will be found to be worthy of their serious consideration.

The vast importance of the electric telegraph, particularly the submarine telegraph, is now generally recognised, and the advantage of our being in almost instantaneous communication with distant parts of of the world is, in a commercial as well as in a political point of view, of the gravest and chiefest importance. Of the practicability of finding a short line across the Atlantic, with a suitable bed for a submarine telegraph to rest securely upon, at a moderate depth, we have now pretty satisfactory evidence, from the recent soundings made by order of the United States' Government between Ireland and Newfoundland.

Now the possibility of laying down successfully lengths of 200 to 300 miles of heavy telegraph cable has also been demonstrated ; notwithstanding the want of success in several instances, from what we know to have been gross ignorance and mismanagement on the part of those concerned, in some of the cases referred to ; but to deal with so great a length of telegraph cable as 3,000 miles in one piece, even though it should be but a single conducting wire, coated with insulated material, and overlaid or protected with a covering of iron wires (strand-like), is a matter of no small difficulty.

The difficulty experienced by the Mediterranean Electric Telegraph Company in obtaining a ship with sufficient capacity, and otherwise suitable for stowing the length of cable intended to join the Island of Sardinia with Cape Bona, on the coast of Africa, was considerable; and although the diameter of the Mediterranean cable was nearly twice that of the proposed Atlantic cable; the length of the former is only about one-fifteenth of what will be required to cross the Atlantic by the shortest practicable route.

To find a vessel capable of holding the whole of the Atlantic cable is a matter of the first importance for the progress and success of the undertaking.

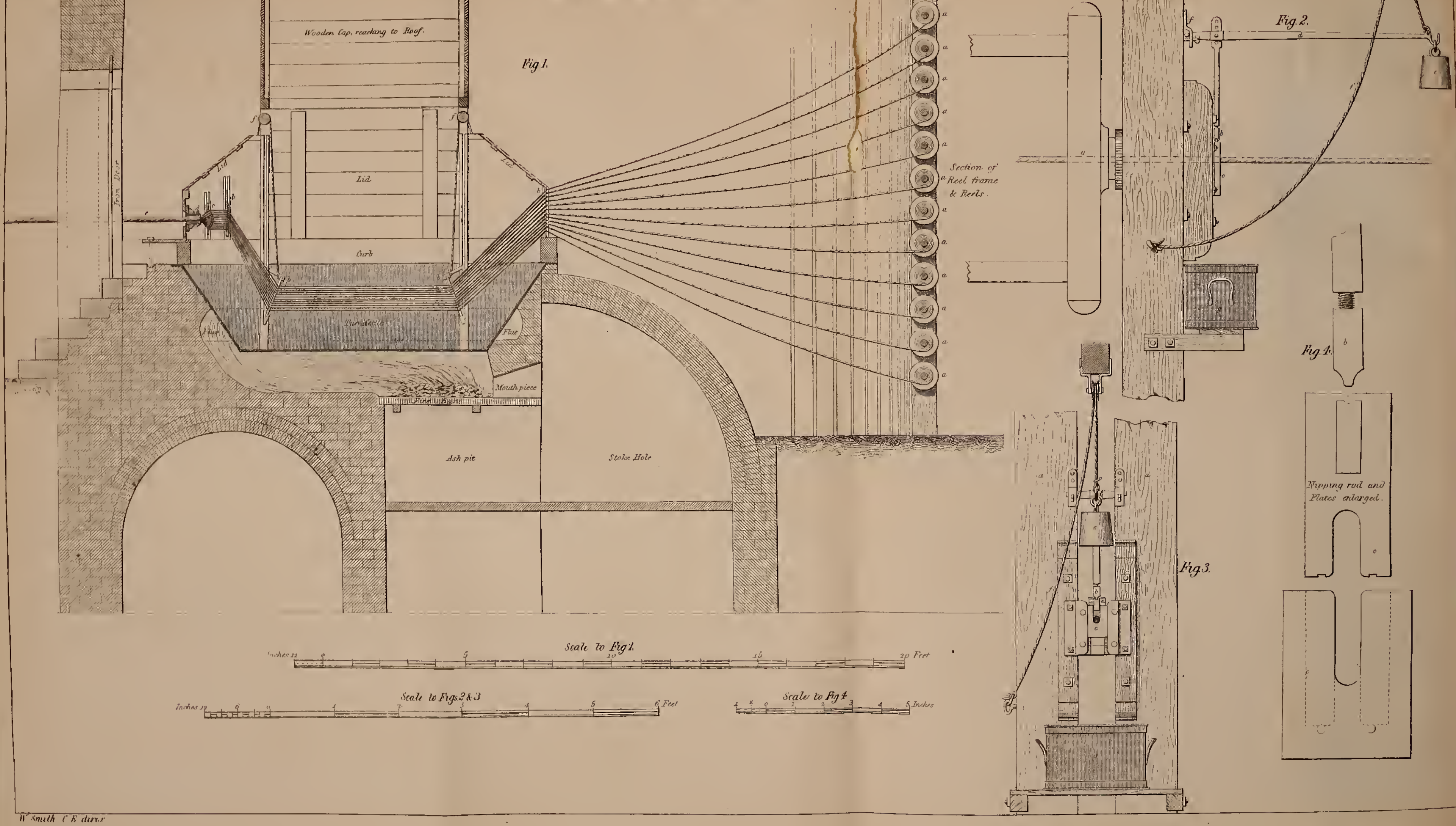
Now our suggestion is, that the first employment of the great ship should be to take on board the entire cable, and thus aid the projectors of another great undertaking of world-wide importance in carrying out their enterprise.

The great ship is in every way suited for this undertaking, and it would be an immediate and profitable employment, in which her sea-going capabilities and the working of her machinery might be practically tested, before incurring the great expense of fitting up her internal arrangements for the convenience and comfort necessary for the purpose of passenger accommodation. Here, also, would be a source of obtaining the means of finishing the vessel according to the original design, in a suitable manner, resulting from the experience gained whilst so employed, and that, too, without calling for the necessary capital from the shareholders.

It will thus be seen that the suggestion for employing the *Great Eastern* was made in our columns October 1st, 1856, having originated about the middle of September with the Author of The Artizan Notices of the progress of the Great Ship ; it was made to Captain Harrison and other officers of the Eastern Steam Navigation Company, in the presence of several scientific gentlemen, in the building yard at

ROPE MACHINERY.

Section of Tarring House and Details of Do.



Millwall; and, moreover, it will be perceived by reference to the last paragraph of the above extract, the concluding sentence of which clearly indicates the difficulties which were foreseen by the writer as likely to occur in obtaining the capital necessary to finish the ship. It is almost needless to add, these anticipations have been fully realised.

Now, although we do not object to a fair use being made of whatever may appear in our columns, or whatever may be contributed to our Journal and paid for by the Proprietors, we do strongly protest against such impudent plagiarism and dishonest wholesale appropriation.

HEMP AND FLAX SPINNING AND ROPEMAKING MACHINERY.

(Illustrated by Plate cxxviii.)

In selecting the subject of Hemp and Flax Spinning Machinery for illustration, we contemplated, as we have already stated, confining ourselves to the preparation of hemp and flax for the manufacture of ropes, lines, &c. Having commenced the series of illustrations in 1857, we have from time to time, as opportunity occurred, advanced the subject until the raw material, the preparation of which by machinery was described, has become fitted, by passing through numerous machines, for conversion into twine, cords, lines, hawser-laid ropes, cables, &c. The raw material with which we commenced is thus left in a condition to be employed, according to the size or number to which it has been spun, for the manufacture of smaller or larger cordage; and we now proceed to describe the preliminary processes to which yarn is subjected when employed for the manufacture of cordage for various purposes.

As hemp ropes have to be differently constructed when employed for different purposes, so also has the material to be differently prepared; and in ropes that are intended for the standing rigging of ships, for hawsers, and for other purposes where the ropes are much exposed to the weather, the process of tarring is resorted to, and in such cases the tar is applied to the yarns or threads hot; but where ropes have to be employed for hauling purposes, as falls in blocks, for the running rigging of ships, the tar is applied cold, and a much smaller quantity is absorbed or taken up by the hemp material; whilst for fine cordage, known as white rope, and for the various kinds of "lines," &c., tar is not employed.

In the present instance we have selected for illustration the process of tarring by what is known as "the warm register," and the accompanying Plate, No. cxxviii., illustrates by Fig. 1 an approved arrangement for a tarring-house and apparatus; whilst Figs. 2, 3, and 4, exhibit the details of the compressor apparatus or tar squeezers through which a bundle of yarns, after passing through the tar-kettle, are caused to part with any superfluous tar.

The building in which the tarring of hemp is performed should always, for convenience of working, be close to the spinning-rooms; but security from fire has, in the opinion of many, rendered it necessary to isolate the tarring-house from the mill, spinning works, or rope ground; but this we contend is quite unnecessary, if due precaution be taken in the erection of the tarring-house, and the setting of the tar-kettle, so that the flame of the furnace employed in heating the tar cannot under any circumstances come in contact with the inflammable vapour given off from the tar whilst boiling. The registering process should also be performed outside of the tarring-house, or the room in which the tarred yarns are registered should be separated by a fire-proof division from the tarring-house.

The construction and arrangement of a tarring-house upon the most secure system is shown in sectional elevation at Fig. 1, Plate cxxviii, where a number of yarns, wound upon bobbins or reels, mounted at one end of the room, are carried through the tarring-kettle in a sufficient number to form a strand, and after passing through a convex perforated plate, are shown as passing out of the tarring-house in a strand-like form.

The fireplace is constructed in the centre of the apartment, which is wholly protected by an arched enclosure of brickwork, the details of which are sufficiently given. For the same reason, the manner in which the tar-kettle is fixed in the brickwork, and is heated by the fire, needs no further elucidation. In like manner may be seen the way in which the tar-kettle is covered by a casing, or funnel, which carries off the fumes of the heated tar through the roof into the atmosphere.

Having ascertained the number of yarns required for the strand, according to the purpose for which it is destined, the same requisite number of reels filled by the machinery, described in a former Number, are arranged in several series upon a vertical square frame constructed for that purpose; a section of one of these series, and of the frame, being represented in Plate No. cxxviii, at *a a*, &c.

The ends of all the yarns from these several reels are brought in a converging direction across the apartment, to a square iron plate *b*, perforated with a number of round holes, and each yarn is made to pass through a separate hole. The ends are then brought in a parallel direction obliquely downwards to another similar plate, *b′*, fixed in the middle of the tar-kettle, and are then directed horizontally towards and through another plate, *b″*, perforated in like manner; then upwards obliquely through a fourth similar plate, *b‴*, and afterwards they pass horizontally to a convex circular plate, *c*, which is pierced in like manner with round perforations concentrically disposed, and through which the yarns are severally introduced—all converging thence into one common point through the register plate, *d*, in which is a cylindrical tube of metal fixed by its collar to a framework made for this purpose.

All the yarns thus brought together in many regular concentric series within this tube here undergo a preparatory amount of torsion and pressure, and the strand thus formed is then conveyed straight to the register machine in the adjoining apartment, in order to undergo a further operation of twisting and compression. The object of heating the tar is twofold: 1st, to render it more fluid, and thus better able to penetrate thoroughly between the fibres of each yarn; and, 2ndly, to communicate to the hemp such a degree of heat as will dispel both air and moisture, for which purpose the temperature is not suffered to descend below 212° Fahrenheit, a thermometer being placed in the heated tar to regulate the fire accordingly. The surplus amount of tar adhering to the threads is first scraped off in passing over the margin of the holes in the plates *b‴* and *c*, and is further squeezed out by the compression of the united yarns in the register tube, *d*. The strand thus impregnated with a full proportion of tar, now passes on to the next operation.

The process just described is called the "warm register," in which it is evident that the tar is made to fill all the interstices between the yarns, which become thus agglutinated into an elastic substance almost impenetrable to water or damp. This is especially well adapted for hawsers, standing rigging, and other kinds of cordage most exposed to the weather, and tends greatly to their durability; but it is found that, in proportion to its impenetrability to the weather, it becomes more rigid, and, therefore, less applicable to running rigging, for which latter purpose what is called the cold register is much used. In this latter process the yarns are previously tarred, and then wound upon reels, which are fixed in a framework similar to that already described. The tar-kettle and the four perforated plates, *b*, are altogether dispensed with, the tarred yarns being passed only through the circular convex plate, *c*, with perforations concentrically disposed, and the register tube, *d*, when the united yarns are forced into a strand, and subjected to the same operation of torsion as that of the warm register before explained.

After the strand of "warm register" yarns has passed out of the tarring-house, it is carried through a compressor in advance of the coiling and registering machinery; it receives the pressure which is necessary to drive off the superfluous tar, and leaves the strand round and firm for the subsequent operation. Fig. 2 is a side elevation, and Fig. 3 a front elevation of this apparatus, Fig. 4 being a view of the nipping plates and rod to a larger scale: *a a* are two uprights, to which the apparatus is fixed; *b* is a rod, having a screw by which the lower end is made to press upon the plates, and by which it is adjusted; *c* is the lower compressing plate or die, and *c c* are the two plates or dies; *d* is a horizontal lever acted upon by a weight, *e*, as shown in Figs. 2 and 3,

and which lever is regulated by pressure upon the sliding-plate, *c*; *f* is the fulcrum of the lever, and *g* a can or tank for catching the tar. After the strand or bundle of yarns has passed this nipper or compressor, it then passes into the registering apparatus, where it is wound upon large drums or bobbins, which are afterwards removed to the strand-laying machine, when the bundle of yarns heretofore described are intended to form parts of strands.

At the earliest convenient period we shall resume this subject.

A FEW REMARKS ON BOILER EXPLOSIONS AND THE CAUSES TO WHICH THEY ARE ATTRIBUTED.

By EDWARD STRONG.

IN THE ARTIZAN for the month of January I endeavoured, in a few words, to bring before the notice of engineers the very unsatisfactory conclusions in many cases come to as to the causes of boiler explosions. Being aware that the views I hold on this subject were at variance with those held by many engineers, I felt it necessary at first to enter very cautiously on so important a subject; but having had my opinions on this point corroborated by an eminent engineer—Mr. Roberts, of Manchester—I may venture to enter more fully into this.

We may take it as granted, that it is the wish and duty of all engineers, when one of these unfortunate accidents occurs, to use every means in their power to trace out the true cause of the accident; and when commencing such an inquiry, it should be thoroughly understood that in all these cases the accident must have arisen from either a defect in construction, or neglect of the owners or parties in charge of the boiler. And bearing this strictly in view, I cannot see but that a satisfactory result should be come to; and the defect or neglect ascertained would be the information engineers require to avoid and remedy for the future. Adopting this system, in preference to that of endeavouring to evelope the case in mystery, we might hope to look forward to boiler explosions being very rare, instead of every-day occurrences.

Under the heads of "mysteries" may be classed two theories: the first, the supposition of an explosion of hydrogen gas, from the decomposition of water, from the plates of the boiler having become overheated; the second, from the same cause (overheating of the plates), the water having taken the spheroidical form. It will be necessary to treat these two theories separately before entering into plain practical facts.

The opinion, and which I have often heard expressed by engineers, is, that the plates of a boiler (no distinction being made between those of iron and copper) having become heated to redness from shortness of water, a gas is generated as explosive as gunpowder. Now it can only be said that under such circumstances, hydrogen gas, one of the ingredients of an explosive mixture, becomes present in the boiler; but in this state it is harmless, as pure hydrogen will neither ignite or explode, and only becomes dangerous when mixed with certain proportions of air or oxygen gas, neither of which should be present in boilers working. It is therefore evident that this theory rests only on suppositions, commencing at first in doubt as to whether the very fact of the plates being heated to redness, and thereby weakened, may not from this cause have given way and caused the explosion; and ending in doubt as to whether or not the hydrogen gas could have become explosive by an admixture of air, and how this air had become present in the boiler. The whole of this theory should be thrown aside, as at best it can only be shown to be the result of a prior defect, which defect is the one to be looked for, as had it not existed the boiler plates would not have become heated: it is the real cause of the accident. This cause can be easily traced to a practical fault, namely—either the entire want or improper condition of the lead plug.

But, although iron heated to redness has the property of decomposing water, it must be thoroughly understood that copper has not, as copper will not decompose water at any temperature; therefore, where the boiler is constructed of this metal, or, as in the case of a locomotive, where the fire-box is of copper and the tubes of brass, the decomposition of water from these parts being heated is impossible, and the theory must not be allowed to be applicable to such a case. This I saw unintentionally corroborated in an article on the relative evaporating powers of iron and brass tubes which appeared in "The American Railroad Journal," from which I make the following short extract: "Iron absorbs heat so much more rapidly than copper that many explosions have occurred which would not, had copper been used; although it is admitted, it is too bad to praise copper for this also, that it will not let a boiler blow up. Copper cannot be a good medium through which to raise steam and a bad one to blow up." Now copper has been proved to be a good medium through which to raise steam, being superior in this respect to iron; and its being a bad one to blow up is from the very fact that it will not decompose water, when from a defect the metal has become heated.

Water in the Spheroidical Form.—The supposition that boiler explosions have been caused by the water in the boiler having taken this form arises from this. If a plate of iron is heated to the temperature at which water boils, or to certain degrees beyond this, water being then thrown upon it evaporates in the form of steam, but if the plate is heated considerably beyond this temperature the result is different, as water then thrown upon it ceases to evaporate in the form of steam, and takes the spheroidical form, which is that of rolling on the surface of the heated metal in globular forms. If this water is allowed to remain on the metal until the temperature of it is gradually reduced to the point when water ceases to remain in the spheroidical form, it then rapidly evaporates in the form of steam. It is therefore said that the plates of a boiler may have become so much overheated as to cause the water in contact with it to take the spheroidical form, and that the heat of the plates has afterwards become reduced to the point where the spheroidical form of water ceases, and that then the evaporation of steam becomes so great that an explosion must ensue. It is mere supposition that an explosion should follow, never having been proved by an experiment, and there is every reason to believe such should not result from this, which I will endeavour to show.

Water is said to take the spheroidical form at a temperature of 340°. Allowing this to be correct, the ordinary working pressure of locomotive boilers is 120 lbs.: to raise steam to this pressure a temperature of 343° is required, therefore water at this pressure must be in the spheroidical form, and, according to this theory, whenever the pressure falls say to 110 lbs., the water ceases to be in the spheroidical form, and an explosion should follow; which I need hardly say, in practice, does not take place. But if there is any doubt in this case, we can go still further. Engines have been worked with perfect safety at a pressure of 200 lbs., requiring a temperature of 385°. I have seen the pressure of steam in these boilers gradually reduced to 100 lbs., without the least perceptible result beyond the reduction of pressure. The pressure of steam in a boiler has been raised to 300 lbs., and afterwards reduced, without the least symptom of an explosion. These are facts of themselves sufficient to prove that attributing boiler explosions to water having been present in the spheroidical form is an absurd thing.

Water in boilers which are not stationary must frequently be in the spheroidical form, without any explosion resulting, as from their motion it occurs that a portion of the plate exposed to the fire is left for a time without a covering of water; this portion of the plate gets overheated, and on the position of the boiler being again altered the flow of water returns, and is brought in contact with the overheated plate. I have never known an explosion result from this, and yet I have frequently seen this occur—as, for instance, a locomotive ascending a very steep incline, and immediately afterwards descending a steep decline. I do not mean to say that with proper care—keeping the water sufficiently high in the boiler—this would have been; but it is well known that drivers do often let the water fall rather too low, and that water in the spheroidical form must frequently be present in the boiler. But it is evident that water being present in a boiler in this form, can never of itself be the cause of an explosion; and such being found, the theory should no longer be allowed to be brought forward as a means of accounting for such accidents.

If these two theories may be allowed to be finally disposed of, the inquiry becomes a simple affair, as we have thus only to deal with mechanical defects, and these may be classed under three heads, which are, firstly, *insufficient strength of boiler* (from whatever cause this may have arisen, whether from weakness in original construction, or worn so from being long in use, or from a neglected leakage, or plates injured by action of fire, from either an accumulation of dirt in boilers or insufficiency of water); secondly, a *defective safety-valve;* and, lastly, a *defective lead plug.* All boiler explosions may with certainty be said to be caused by one of these three defects.

Insufficient Strength of Boiler.—As regards the construction of boilers, no rule can be laid down as applicable to all cases—so much depends upon the pressure and quantity of steam required to be generated; but, as regards the form of boilers, one rule may safely be applied to all—that is, to adhere as closely as practicable to the circular form in all the parts. With the large flat surfaces weakness may be said to commence, for however well these parts may apparently be stayed, they are in nearly all cases the weakest part of the boiler, and the most likely to become deranged—the strain on the stays is always more or less unequal. Where the pressure of steam is high, and the quantity required to be generated great, it is always safer to increase the number of the

boilers, rather than to increase their dimensions beyond certain limits. Of the strength of boilers engineers should not be satisfied by only having ascertained by their calculations that the boiler they have constructed is of amply sufficient strength for what is required of it, when it thus leaves their hands *new* ; but they should satisfy themselves that there is an excess of strength sufficient to compensate for the wear of the plates during the number of years boilers are in general considered workable. But even allowing that the calculations in all points have been correctly made, this is not of itself sufficient to insure strength, as flaws may exist in the metal which the most practised eye cannot detect, making all calculations valueless. The only means to insure against these defects is, testing the strength of the boiler by hydraulic pressure to at least double the pressure it is intended to be worked at. But for this to be an effectual safeguard against explosions from weakness of boiler, it is necessary that this testing be renewed periodically—say annually—which can very easily be done. One of the most common causes from which boilers become weakened is a neglected leakage; it may often be seen how a plate originally 3-8ths in. thick is rapidly reduced to 1-8th in. by the corroding action of the water escaping from the faulty part. A leaky boiler may also be said to be an encouragement to the party in charge of it to allow an accumulation of dirt in the inside of it, as he finds the leakage less troublesome when the boiler is in this state, and thus the injury to the boiler increases, as where the dirt is, the water cannot be in contact with the plate, and then the action of the fire upon it is very injurious. This also greatly affects the steaming powers of the boiler, the dirt always being a bad conductor of heat. The parties in charge of boilers should be made to understand the great danger which ensues from a leakage, however small, being allowed to continue, and also the necessity of keeping the plates of the boiler as clean as possible.

Defective Safety-valve.—It is absolutely necessary that every boiler should be fitted with a safety-valve; on no account should one safety-valve be allowed to act for two boilers, or, as is sometimes the case, for four or five; in all these cases each boiler is fitted with a stop-cock, which has the power of closing all communication between the boiler and safety-valve. It is therefore possible that, either from accident or neglect, this cock may be closed in one of the boilers in which steam is being generated: an explosion would then be inevitable. The danger of this system of construction is so plain to every one that it may be supposed to be sufficient for its own remedy, yet it is not so, as this system is extensively in use; and what appears still more strange is, that even in the Government service it is adopted, or, perhaps more properly speaking, allowed. On the necessity of every boiler having a separate safety-valve, I would go still further and say, each should be fitted with two, as in a locomotive. It is possible that one valve may become locked, but it is almost impossible that two can be so at the same time. I will not attempt to give an opinion as to which is the best arrangement of safety-valve to adopt, there are so many different plans, but those which are the most simple should be preferred, being less liable to become deranged. Explosions are frequently caused by safety-valves having become locked through a defect; these defects are various, although all leading to the same results. What would assist in preventing this would be making all the working joints of brass, which would not thus become corroded by the action of the steam. At present, the lever and working joints are of iron; they become so corroded by the continued action of the steam, that considerable force is often required to work them. It may be said that a brass lever would not be of sufficient strength, but this objection might be avoided by allowing the lever still to be of iron, and at the working joints to face and bush it with brass.

Safety valves often become locked, although in perfect working order themselves, from a defective arrangement of the spring balance; this is an error which is unfortunately very common. If we take an ordinary spring balance, constructed, say, to work at a pressure up to 120 lbs., in screwing it down to this pressure it will be seen that the index finger is brought within 1-8th of an inch of the guard at bottom of balance: this with the ordinary arrangement of lever gives only 1-40th of an inch for the valve to rise; and even this is not its most dangerous feature, as if the connecting-rod to which the balance is attached is not adjusted with the greatest exactitude, but left 1-8th of an inch too short, on the nut of balance being screwed home the index finger rests on the guard of balance; thus the safety-valve becomes effectually locked. I have known lives lost from an explosion which I could only attribute to this which might be thought trifling defect. The index finger should always be at least 1 in. clear of the bottom guard of balance, after the nutis screwed home.

One of the safety valves of a boiler should always be within easy reach of the person in charge, so that he may frequently try if the valve is working freely.

Defective Lead Plug.—To this cause should be attributed all boiler explosions from overheated plates. The safety of the boiler depends as much upon the lead plug being in proper condition, as upon the state of the safety-valve. Men may neglect their duty and allow the water to fall too low, but when the boiler is fitted with a proper lead plug, the most serious result which can follow this neglect is the fire being extinguished. A lead plug to be in proper condition should be renewed monthly, and of sufficient size, not less than 1 in.; where they are thus used, the overheating of a boiler from scarcity of water is a matter of impossibility. But notwithstanding this, the lead plug has got into disrepute, not from any defect of its own, but from neglect or ignorance of those whose duty it should have been to have seen it kept in proper condition. The result of this is that a number of boilers are now not fitted with lead plugs, or else where they are fitted in at first, they are afterwards so much neglected as to be perfectly useless when their safe action is required. The proper use of the lead plug should be insisted upon as one of the greatest means of safety.

The means to be adopted for preventing boiler explosions may be summed up in these few words: the strength of the boiler to be annually tested by hydraulic pressure to double its working pressure; a leakage, however small, to be at once stopped; the boiler kept clean; the boiler to be fitted with two safety-valves, and a lead plug, kept in proper condition. Where these directions are strictly attended to, a boiler explosion may be said to be an impossibility.

LOCOMOTIVE BOILER EXPLOSION AT SHARP, STEWART, AND CO.'S WORKS.

On reference to our "Notes and Novelties," mention will be found of a fatal boiler explosion which occurred on the premises of Messrs. Sharp, Stewart and Co., the eminent locomotive builders, Manchester, whilst they were testing the boiler and machinery of an unfinished locomotive engine, and by which the life of the highly talented and much respected manager of the works, Mr. Thomas Forsyth, was sacrificed; as also the lives of several others who were present.

Mr. William Fairbairn having been requested by the coroner to examine the boiler and report thereon, and as to the cause of the accident, has reported at great length, with his usual ability and care; and as his report contains all the more important details concerning the boiler and connected with the accident, we have given it below *in extenso.*

There is one material point with which Mr. Fairbairn has not dealt, although he has slightly alluded to it, which we think deserves especial attention by engineers: we refer to the defects in the practice of punching and rivetting plates.

During a discussion which took place some time ago at the Institution of Civil Engineers, Mr. Edward Humphrys, whose extensive practical experience entitles his opinion on any practical scientific question to the highest respect, called attention to the prejudicial effects which arise from the defective construction of punches and bolsters, and from the subsequent employment of the more powerful means of rivetting by machinery which are frequently adopted. If we remember aright, and our recollection is aided by some remarks which have been made upon this subject by Mr. Charles May, C.E., the observations which were made by Mr. Humphrys to which we allude, went to show clearly enough that the edges of plates prepared for rivetting, and afterwards rivetted, were very materially weakened from two causes—first, from the punch employed being smaller than the hole in the bolster; and being round at the point and taper, it very materially strains the iron surrounding the hole, particularly in the direction of the line of the row of rivets, and leaves the holes smaller in diameter than the punch with which they have been pierced; and, secondly, by the employment of steam rivetting machines the edges of the plates are further weakened; and the mischief which has been produced by these two causes has become more difficult of detection, because joints so made are much neater, closer, and more uniform, than where hand rivetting is employed.

Now this subject requires the serious attention of boiler makers, and it will be well for them to resort to other and more accurate and powerful means of judging of the state or condition of work produced in the course of punching and rivetting up boiler plates. We have had within the last few days presented to us some specimens of plate-iron joints which, after being subjected to the most rigid examination by experienced boiler makers, were pronounced as not to be excelled; but upon filing off the outer surface of the over-lapping edge of each plate, a powerful lens at once exhibited the greatly strained and weakened condition of the metal between the rivet holes, and upon applying acid, the better to develope the structure of the iron, the distortion—indeed, the disintegration of the metal at the edges of the plates was made plainly visible without the use of a lens; and as this specimen is a type of the most approved joint-making for boiler purposes, we need scarcely add that however good originally the whole of the plates might have been, and indeed the body of the plates appeared to be at that time, notwithstanding the appearance presented by the edges, a boiler constructed of such plates with such joints would have been torn asunder at the rivet holes by a pressure somewhere between 100 and 200 lbs. per square inch, instead of being able to withstan an internal pressure of 480 to 490 lbs. per square inch, which a boiler constructed of plates of the same thickness and quality would have done, if the plates were in other respects unimpaired.

With these observations we proceed to give an authentic verbatim copy of

the report prepared by Mr. William Fairbairn, F.R.S., C.E., who had been appointed by the coroner to make an examination of the remains of the boiler :—

Mr. Fairbairn said, the inquiry into the causes of this lamentable accident is surrounded with more than usual difficulty. The apparent contradiction of the facts—on the one side, the lowness of the pressure, the satisfactory condition of the safety-valves, the entire newness and supposed strength of the boiler, and on the other the terrible destruction of human life—renders this explosion especially remarkable in the remarkable records of such events. In pursuing my investigation, two separate and distinct subjects forced themselves on my attention :—First, whether there had been any excessive pressure of steam in the boiler sufficient to occasion rupture, had everything been sound; second, whether the material of which the ruptured part of the boiler was composed was defective in its manufacture, or had been accidentally injured in its subsequent working. To one of these two causes—either an over accumulation of force in the interior of the boiler, or a defective plate—must be attributed, in my opinion, the unfortunate casualty under consideration. In regard to the former, there is the evidence of persons who were present from the commencement of the testing until the explosion to show, that the steam was blowing off at both safety-valves during the whole time the engine was standing, and that the balance springs and the Schaeffer's guage indicated a pressure of 117 lbs. to 118 lbs. on the square inch. I have examined with great care the whole of the valve mountings, and find that the boiler had two safety-valves, $4\frac{3}{8}$ in. in diameter, screwed down by levers 38 in. long to spring balances, which indicated the pressure per square inch in atmospheres. The distance from the fixed end of the lever to the valve was 3·54 in., and from the fulcrum to the end 34·58 in., which gives a leverage upon the valve of about 10·7 to 1. The lever and spring balance have been carefully tested, and I find a discrepancy of 9 lbs. per square inch between the actual pressure in the boiler requisite to lift the valve and that indicated by the balance; or in other words, when the balance was screwed down to seven atmospheres = 105 lbs. per square inch, the actual weight upon the valve was 114 lbs. This excess of strain beyond the indicated pressure is not due to any defect in the spring balance itself, but to the weight of the valve and lever not having been allowed for in the scale graduated upon it. The greatest pressure at which the engine was intended to work was eight atmospheres = 120 lbs. on the square inch: and the balance itself was graduated to indicate that pressure and no more. At the ordinary working pressure of seven atmospheres, there was a range or lift for the end of the long arm of the valve lever of $2\frac{1}{8}$ in., and this permitted a corresponding lift of 2-10ths of an inch in the valve itself. This rise opened an annular space equal to $2\frac{1}{4}$ sq. in., or a total of $5\frac{1}{2}$ sq. in. for the two valves, equivalent to a pipe of $2\frac{5}{8}$ in. in diameter.

At this point the question arises whether or no an outlet of $5\frac{1}{2}$ sq. in. was sufficient to carry off the excess of steam as fast as it was generated in the boiler? To this question I would reply—Judging from the immense velocity with which steam at so high a pressure issues from an aperture, and from a knowledge of the daily and usual working of locomotives whilst standing on railways,—that the area of opening was amply sufficient, and it therefore follows (the safety-valves being in every respect efficient and excellent in construction) that the accident did not arise from excessive pressure in the boiler. I am further confirmed in this opinion from the fact that the Schaeffer pressure gauge, which I tested after the accident with water pressure, was found quite uninjured, and invariably returned to zero after frequent pressures had been applied. We have now to inquire how far the boiler itself was calculated to ensure safety. So far as the proportioning of the parts and the thicknesses of the plates are concerned, there was no defect; and it can be demonstrated, that supposing the material perfect and the rivetting sound, the boiler was adequate to resist a force of at least 500 lbs. per sq. in. To show this I have appended the formula for calculating the strengths, and I may observe that I have also found, as the result of a series of careful experiments, that the ultimate tensile resistance of boiler plates is as given in the following table* :—

	Mean breaking weight in the direction of the fibre in tons per sq. in.	Mean breaking weight across the fibre in tons per sq. in.
Yorkshire plates	24·765	26·763
Derbyshire plates	21·780	18·650
Shropshire plates	22·826	22·000
Staffordshire plates	19·563	21·010
Mean	22·519	23·037

The mean strength of boiler plates varies, therefore, from 20 to $25\frac{1}{2}$ tons per square inch. The plates in the exploded boiler being properly proportioned to its size, and the workmanship being everywhere excellent, there remains, in my opinion, but one other alternative to account for the explosion: the presence somewhere or other—in all probability, unseen and not discoverable—of weakness in the plate itself. The following experiments upon pieces cut from the exploded plate appear to strengthen this opinion, and enable us to compare its powers of resistance with the above standard of quality. The experiments were carefully made, and it will be found, that although one of the recorded experiments gives a full average tensile strength, and leads me to infer that the iron of the body of the plate was good, yet the weak powers of resistance exhibited by the other experiments, especially No. 1, indicate the presence here and there of what I may call patches of inferior iron, and show that the plate was not of uniform strength throughout :—

Experiment 1.—Breaking weight per square inch of iron drawn asunder, across fibre, 10·456 lbs. = 4·667 tons.

Experiment 2.—Breaking weight per square inch of iron drawn asunder in the direction of the fibre, 45,057 lbs. = 20·114 tons.

Experiment 3.—Breaking weight per square inch of iron drawn asunder across fibre, 31,038 lbs. = 13·852 tons.

Now it is evident from the above, that a plate which yielded to a force of only one-fifth of what it should have sustained, had some of its parts very deficient in strength, and this result is confirmed by the fact that this defect of strength in the plate corresponds precisely with that which would have been anticipated from the bursting pressure of the boiler. The snapping asunder of the plate, in the first experiment, with a weight of $4\frac{1}{2}$ tons to the square inch, was quite unlooked for; the fracture, however, on careful examination, appeared sound, and it must be inferred that this end of the plate contained some original and unseen imperfection, such as I have before alluded to; and that in *that* part the iron was what is technically called burnt or red short. In explanation of such defects of manufacture, we have only to refer to the acknowledged difficulties which iron makers have to encounter in rolling plates of large dimensions. There is considerable danger of the ends becoming defective, and this happens with the very best makers. It is a mistake, therefore, to suppose that increased strength is invariably obtained by lessening the number of joints in boiler constructions. Such practice is accompanied by the risk of a want of uniformity in the strength of the material. A similar objection applies to very thick plates, which are seldom of the same tenacity as thinner ones, the latter being, in fact, much better adapted for boiler making in general, not only from their superior strength and soundness, but from their superior conducting powers in the transmission of heat.

There is another rather prevalent custom which I consider it my duty to caution the public against, now that they are fully alive to the necessity of obtaining increased security against these explosions. It is a frequent practice to purchase boilers by weight, and amongst the uneducated and unreflecting the apparently natural, but very illogical deduction is made, that the more they get for their money the better. Now the contesting after the cheapest rate per ton in purchasing a boiler is destructive of every sound principle which should be studied in their construction, for the maker, often acting under the influence of a keen competition, is tempted to offer low terms and make up the deficiency by thicker plates and increased weight; and the result is, that the purchaser often pays more for his boiler of increased weight than he would for one of superior strength of thinner plates. I make these observations for the interest of all, and especially those who erroneously suppose they are consulting economy in such bargains. Reverting to the accident under consideration, it is impossible to state with certainty what part of the joint first gave way to the force of internal pressure; but I am inclined to think that the first rupture occurred in the line of rivets next the smoke box, and close to the corner of the longitudinal joint, as it was at this point of the plate that the weak part was found which yielded to the comparatively small force of $4\frac{1}{2}$ tons to the square inch. Assuming this part to have contained from the first such an element of weakness, it will at once account for the fracture at a comparatively low pressure. Moreover, it is stated that the shock of the explosion forced back the whole mass of the engine, in the direction of its length, upwards of 30 ft.; showing that the first rush of steam out of the boiler must have been in the direction of the smoke-box, and that the longitudinal movement of the engine was due to the recoil.

In conclusion, I have to state that I cannot attach blame of any kind either to the manufacturers of the plates or to the makers of the engine. A similar accident might have taken place in my own or any other works. We are subject to such casualties at all times, and although I do not say it would be *impossible* to discover certain elements of weakness in the materials of which the locomotive engine and other constructions are composed, yet with all the ordinary precautions, such as are used at the Atlas Works and all other well-conducted establishments, it may happen that a hidden source of mischief may escape detection, and that we may have to deplore such an event as has occasioned this inquiry.

WM. FAIRBAIRN.

---

* It can be easily shown (see "Useful Information for Engineers," p. 39) that if—

d = internal diameter of boiler;
l = length subjected to bursting pressure;
l' = length after deducting part punched out for the rivets;
P = the bursting pressure;
c = the thickness of the plates; and
T = the tenacity of the material;

Then the pressure of the steam to produce longitudinal rupture = d, l, P. The resistance opposed to this strain is evidently the area of material in the longitudinal section multiplied by its tenacity, = $2\ c,\ l'\ T$. Now at the moment of rupture the bursting pressure is equal to the resistance of the material; that is, $d\ l\ P = 2\ l'\ c\ T$; or,

$$P = \frac{2\ l'\ c.\ T.}{d\ l} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Now, in the boiler under consideration, taking the measurements given upon the drawings of the engines; — $d = 51$ in.; $l = 37·7$ in.; $l' = 20·6$ in.; $c = 0·5$ in.; T = the tenacity of the material we may take at, at least, 20 tons, or 45,000 lbs. per sq. in. Hence, in this case—

$$P = \frac{2 \times 20·6 \times 0·51 \times 45000}{51 \times 37·7} = 480 \text{ lbs.}$$

Or, in other words, 480 lbs. per square inch is the pressure requisite to burst a boiler of these dimensions. But it is to be observed, that the crossing of the joints in a locomotive boiler increases to some extent its power of resistance. If we take for the tenacity of the plate 4·667 tons per square inch, or the lowest result arrived at in the experiments on the exploded plate, we get as above, for the bursting pressure of the boiler—

$$P = \frac{2 \times 20·6 \times 0·51 \times 10450}{51 \times 37·7} = 113 \text{ lbs.}$$

A very remarkable approximation to the alleged pressure in the boiler.

PROFESSIONAL DOINGS IN DUBLIN.

FROM OUR OWN CORRESPONDENT.

The long vexed question of paving *versus* MacAdamising, as it concerns the streets of Dublin, appears to be fast settling down, and although very noisy in its triumph, paving appears to have won the day. Eden-quay, Grafton-street, and Earl-street, all bear testimony to its desirability, and have stood the test so far very well.

Carlisle-bridge is being reduced in the height of the roadway, which we hope is merely a forerunner of something being done in the right direction. The most feasible method of improving this bridge would be to take down the facings on either side, rebuild them in line with the houses of Sackville-street, and add so much to the arch sheetings.

The new buildings, in addition to the Four Courts, are fast assuming an appearance of shape, and are being executed under the direction of the architect of the Board of Works. The contractor is Mr. Meade, of Westland-row.

We have rarely seen an instance of the evil of building without professional assistance so glaring as in the case of the large hospital in Eccles-street—"Mater Miserecordia," as it is called. It appears that the plans were prepared by an "*intelligent*" carpenter, and consequently the building teems with examples of what is not inaptly termed Carpenter's Gothic—an immense misshapen attempt in a style which we freely acknowledge is "*Greek*" to us. Why is it that the trustees of such establishments will thus ruthlessly throw away public money to effect the miserable saving of the professional fees? The paucity of fenestration is the first thing that strikes the eye, and carries one back to the good old times of window-tax; and then the breaks in the front!—with smaller projection than the pediments over the windows. It is strange that a religious body that boast so much of their encouragement of art, should have so few architects amongst them, or at least have such little taste for the employment of architects.

The scientific portion of the Hibernian Academy Exhibition is comprised in four works, two of which are passable, and two wretched. One of the latter is an instance of the good taste of the Ulster Banking Company, who very properly rejected it when sent in for competition. There is a creditable design for the Wellington Testimonial at Liverpool by Mr. McCurdy, and a good Façade for a City Hall by Mr. Wyatt Papworth. This exhibition is open in the evenings at the charge of one penny, and many of the working classes avail themselves of the privilege of passing a pleasant hour after their day's work.

The new wharfs on the North Wall Quay are progressing in the most favourable manner; the contractors are Messrs. Ramsbotham and Robinson; and when completed, this line of quayage will be second to none in the kingdom. But the Board of Works appear to sleep over the improvements that we heard were in contemplation in the matter of the swivel bridges and the new sills for the old dock gates—improvements which the daily increasing requirements of the Dublin Quays loudly call for.

The new graving dock will soon be opened. The contract for supplying the necessary pumping apparatus has been given to Messrs. Easton and Amos, who will doubtless complete it in their usual prompt manner. Apropos of the graving dock, we have heard a rumour of the contractors having claimed a large sum for extras, and that Sir W. Cubitt has been engaged on the part of the Dublin Corporation to look into the matter, and is, or will shortly be, in Dublin for that purpose. So much for the patriotism of that enlightened body! One would think that there were no engineers in Ireland worthy of any confidence. However, Sir William appears—and very deservedly—to be the great umpire in all the difficulties of the Corporation; and a portion of the quay near the Custom House is on some maps called Cubitt's Quay, in memory of the talented designer.

The Messrs. Crowe and Son have in hand the great alterations of the Royal Bank of Ireland, and new buildings for the Mining Company of Ireland, at Ballycorus, in County Wicklow; Messrs. Carmichael and Jones, being the architects.

The new cattle shed, in the courtyard of the Dublin Society, is fast coming to a finish; it is very large, and capable of affording accommodation to the great number of live stock which are periodically sent here for exhibition. The design was the object of competition, and the premium adjudged to that bearing the motto "*Never venture, never win*," which was submitted by Mr. J. J. Lyons, of Gardiner-street.

We learn, in professional circles, that the National Gallery and Dargan Testimonial will shortly commence, and hope that something more creditable will be the result than the Museum building, which has been found inadequate for the purposes of exhibition.

The Terminus of the Dublin and Wicklow Railway, in Harcourt-street, is progressing rapidly, and will reflect great credit on the builder, Mr. Cunningham; the architect is, we believe, a Mr. Wilkinson, who was for some time connected with the Poor-Law Commission.

The Ballast Board have commenced operations at Barrack or Bloody Bridge. The contractor is a Mr. Killeen, and the design, which is exceedingly graceful, is from the pencil of Mr. George Halpin, C.E., the engineer to the Board. Mr. O'Connell, the foreman carpenter to the Ballast Commissioners, attends daily to watch the progress of the piling.

THE NEW BARRACK BRIDGE.

Many of our readers are probably aware that the river Liffey, in its course through Dublin to the sea, is bordered by, on either side, 3 miles of quays, unequalled, perhaps, for regularity and extent by any other city in her Majesty's dominions. Of these 6 miles, 3 are made available for shipping, and are situate below Carlisle Bridge, the remaining 3 being occupied by shops, merchants' stores, and dwelling-houses. Three miles from the end of the North Wall Quay is the first bridge properly in the city; it was built in commemoration of the visit to Dublin, in 1821, of George IV., from a design by Mr. Papworth. The next bridge is the subject of our present article. The old Barrack, or, as it is more popularly called, Bloody Bridge, is fast being removed to make way for the new bridge, and was the last remnant of the four ancient bridges which a century since spanned the river. Latterly this old bridge was anything but a picturesque object, and, in a sanitary point, it was a positive nuisance; but for many years an embattled gateway, built from the designs of Johnstone, the architect, stood beside one of its approaches, and, in connection with it, formed a pleasing termination to the vista of the quays. The increasing traffic, caused by the erection of the terminus of the Great Southern and Western Railway in the neighbourhood, caused this gateway to be removed, and the old bridge became a deformity; it also showed signs of a break-up in the northern abutment, which obliged the Corporation to close it as a carriage-way by building walls across it, and it very soon became a receptacle for rubbish, and, as we said before, a nuisance.

The public were not long in complaining of the eyesore, and in August, 1855, the Engineer of the Corporation for preserving and improving the Port of Dublin was directed to submit plans, &c., for a new bridge. The Corporation decided on adopting a cast-iron bridge, resting on stone abutments. Some misunderstanding as to how the money was to be raised occurred between the Port of Dublin Corporation and the municipal body, which had the effect of delaying the erection of the bridge to the present time; but the work now goes on bravely under the care of the contractors, Killeen and Co.

The abutments, which will be founded on the rocky bed of the river, are to be built of county Dublin granite, and are rusticated from low water to the springing, above which they are carried up plain to the cornice, consisting of two broad fillets, over which rises a bold and deep cavetto, ending in a plat band, and surmounted with a broad drip stone. The upper portion of the pilasters form pedestals, with panelled dados, finished by a similar cornice and newel block.

The arch, of 95 ft. span, and a rise of 9 ft. 6 in., is composed of seven ribs, five castings in each forming voussoirs, starting from a skew-back plate of cast iron, all securely bolted and braced together in a manner highly creditable to the constructive skill of the designer. The roadway is supported by spandrils, cast with arched openings, and possessing with great strength a most uncommon appearance of lightness. On these spandrils are laid the continuous girders, which bear the road plates, these being the now generally used and appreciated buckled plates of Mr. Robert Mallet, the well known engineer of Dublin.

The parapets and cast-iron cornices over the arch are supported by the facing spandrils, which differ slightly from the inner, and are secured in a manner different from anything we have seen adopted before. Extreme strength was required, and apparent lightness, to make the parapet accord with the other portions of the bridge, and to obtain both these requisites was a matter of no small ingenuity. The design, with its various calculations and the necessary tests and experiments consequent on a work of such importance, was the work of George Halpin, Esq., and will no doubt, when completed, reflect great credit on that gentleman, who since his father's death has followed in his footsteps in improving and beautifying his native city. We purpose giving drawings in detail of the bridge during its progress, which will no doubt interest our readers.

EMBANKMENT OF THE SEINE.

Whilst the improvement of the Thames, more especially as regards its embankment, is still, with the dwellers on its borders, but little more than a vexed question, scarcely, in practical result, advanced from the rank of speculative hypothesis, our Gallic neighbours have been steadily and surely, year by year, and despite the interruptions of dynastic change and political convulsion, advancing towards the completion of one of the most gigantic engineering undertakings of the present day—the entire embankment of the river Seine—an onerous task hitherto on the patience and resources of successive governments, but which is now proceeding with apparently uninterrupted success. The evils formerly, from various

quarters, prognosticated as likely to ensue from it—for the course of great undertakings, in commou with many other affairs in life, is rarely remarkable for smoothness—the dreaded fall of tide in the various border ports, the destruction of side-works in others, the blocking up of approaches, &c. &c.—have been proved by actual results, so far as the works have progressively been completed, to be wholly visionary or greatly exaggerated. The banks and cuttings (as at Tancarville, for instance) which, according to certain misgivings, were to be bodily swept away by the combined action of wind and tide, have hitherto stood, and promise for all time to stand proof to all the threatened elements of danger. The low-tide level has, it is true, sunk a little at Villequier, and throughout the course of the Seine up to Rouen—at Villequier from 60 to 70 centimetres, and at Rouen from 30 to 40 centimetres; but the high-tide in both these localities takes place 30 minutes earlier than heretofore, and remains longer at its maximum. And even should the contemplated extension of the cuttings up to the sea cause a subsidence of 50 ceutimetres in the port of Rouen, this would in no way interfere with the maritime advantages of that port, whose channel offers a depth throughout its whole course of from eight to twelve metres of low-tide water, aud in which the recurring tide causes every twelve hours a rise of from 1 metre to 1½ metres.

The result of the cutting at Tancarville fully justified the calculations of the engineers as to the anticipated course which would be taken by the river at high-tide, as modified by the works for confining its current. Ever since the tides of March last, the waters of the Seine, constrained by the works in question, have forced a passage through the Tancarville bank, so that henceforth the embankment of the Seine may be considered as completed up to the entrance to the bay. The notorious bar at Villequier, disastrously famed for the many accidents it had formerly caused, has entirely disappeared, and instead of the scarcely 3 metres of water which formerly covered this spot of the river passage, there is now a usual depth of from 6 to 7 metres. A corresponding depth now exists throughout the course of the embanked channel, reckoning from Tancarville to Mailleraye; and from this latter point up to Rouen the soundings give, with the exception of a few shallows which are in course of being dredged, the normal depths of from 8 to 10 metres, which have always heretofore existed there. The sand bar, which was formerly the dread of navigators, is henceforth annihilated; or, at all events, will cease to offer the slightest obstacle to the passage of laden vessels.

The trifling fall observable in the level of the Seine in the port of Rouen is by no means to be attributed exclusively to the embankment-works; a great portion of this decrease is traced to the general falling off in the waters of the Seine, from Paris and upwards down to Rouen: a falling off, by the way, which for the last two years has been perceptible in most of the other rivers of France; and in proof of this it may be remarked that every time there is a rise in the Upper Seine, the level in the port of Rouen rises in proportion, and subsides as and when the rise diminishes.

It was at first, and not perhaps unreasonably, apprehended that the lowering of the shelves on the Meules Bank, and at the *Traverse* or cross-ridge at Villequicr, would cause a considerable subsidence of water-level in the port of Rouen; but subsequent experience has demonstrated that notwithstanding this element of depression, the fall at Rouen is scarcely perceptible. This is to be accounted for by the numerous windings or sinuosities of the river, whieh retard the flow of the waters, and by the diurnal action of the tide—which, ascending the Seine twice in the twenty-four hours, fulfils the office of a break in resisting for several hours each day the escape of the water, and in a mauner thrusting them back on the retaining sides. But for this natural check the waters would flow down rapidly to the sea, and thus diminish considerably the soundings in the port and its vicinity. For a similar reason, the embankment and clearage works, when pushed forward, even up to the sea, will not have the effect of injuriously diminishing the mean tide level in the port of Rouen.

When some shallows that now exist between Rouen and La Mailleraye shall have been dredged, and the embankment continued to the sea, vessels drawing 7 metres of water will be able to ascend the Seine at every tide; meanwhile, thanks to the passage now cleared to Tancarville, vessels with a draught of 5 metres can be towed in a single flood tide up to Rouen without fear of aceident. Formerly the waters, after having scoured the banks and shores of the river, reached with the flood tide to La Mailleraye charged with sand and mud, and returned in the same state towards the same; so that the Seine was taxed with choking up the roadstead, and even the port of Havre. The river merely carried back to the sea what the latter had washed into it.

The actual expense of the embankment, euttings, &c., up to the present time (the undertaking dates from the year 1807) has been something more than 60,000,000 of francs (£2,400,000), and the additional outlay of some few hundred thousand francs will suffice to complete the works to La Roque; so that for an outlay of about 7,000,000 francs, the navigation will have obtained the immense benefit of being able to ascend the Seine with a 5-metre draught of water, where formerly a vessel drawing 3 metres only could scarcely accomplish the voyage; to say nothing of the gain to the State of upwards of 5,000 hectares of valuable land, the recovery of which is entirely due to the embankment. The projected extension of the works, however, to Honfleur is strenuously opposed by the Port and shipping interests of Havre, who dread (whether reasonably or not is one of the great questions at present agitated in the French journals) the consequent (as they allege) gradual blocking up of their port by sands and débris. A similar prejudice—for such we feel justified, from all analogous experience, in calling it—existed in Scotland when the improvement of the Clyde was in question. The Port of Greenock strongly opposed the measure in and out of Parliament, and for reasons precisely similar to those now urged by the Havre folks, namely—that the works solicited by Glasgow would infallibly have the effect of blocking up their port. The Clyde was, however, improved; vessels of heavy tonnage now reach up to Glasgow, and still the port of Greenock remains unencumbered with sand. The combined action of the increased current and of the dredging operations has been, in a length of from 18 to 20 kilometres, to clear the bed of the river of upwards of 75,000,000 cubical metres of alluvial soil, which, now lodged for good behind the embankments, form on the right-hand shore an extent of 2,500 hectares of what, it is calculated, will one day prove most valuable meadow land. On the left bank a reclaimed surface of about equal extent is being daily formed in the bay of the Vernier Marshes (Marais-Vernier), and the improved value of the land thus recovered, whether for pasturage or building purposes, will, it is confidently anticipated, go a far way towards compensating for the heavy outlay incurred.

DESCRIPTION OF TWO PAIR OF HORIZONTAL PUMPING ENGINES.

By E. A. Cowper.*

(Illustrated by Plate cxxvi.)

In offering to the Institution a short description of some horizontal pumping engines recently constructed, it should be mentioned that the Author has done so at the request of the Council, but has been prevented by press of business from making the paper so complete in its details as he would have desired. As, however, he considers it the duty of the members generally to supply to the Institution records of any works they may have executed at all of a novel or interesting character, he trusts that any defects in the paper may be exeused.

If it is desired to work any steam engine economically, it is of course necessary to work expansively, with high pressure steam if possible; and to maintain a good vacuum wherever condensation is at all practicable, so as to allow of the expansion being well earried out. To do this, it should always be borne in mind that the power of the piston varies so much between the commencement and the end of the stroke, that the inertia of a considerable weight for the power to act upon is absolutely necessary, to absorb the extra force of the steam at the commencement of the stroke, and give it out again towards the termination of the stroke by the retardation of the weight. This is done in an ordinary Cornish single-acting pumping engine by the unavoidable weight of the "plunger poles," or solid plungers of the pumps in the pit; or where the same engine is used for waterworks purposes the single plunger is loaded with a "balance bob," sometimes upwards of 40 tons in weight, which of course travels at the same speed as the piston. But in a pumping engine, with a crank and flywheel, the weight to give the inertia is placed in the rim of the flywheel, and travels many times as fast as the pistou, thus increasing its effeet very greatly; and although it does not actually stop as the balance bob does, still it varies in speed quite enough to make up for the variation in power.

There are many Cornish pumping engines that have the steam very much throttled in its passage to the cylinder, with the express view of preventing the high pressure steam from getting fully on to the piston, and causing too great irregularity in the moving power; in some cases, 40 lbs. steam in the boiler reaches the piston at only about 12 lbs. pressure, since the inertia of the balance bob, &c., would not sufficiently absorb a greater moving foree.

In pumping engines with a crank and flywheel the stroke of the pump is eompletely eontrolled; and this arrangement is now universally adopted by the best makers of waterworks pumping engines. The flow or velocity of the water is more regular with a single crank engine, even if worked as a single-acting engine; for the pause or dwell at the top and bottom of the stroke in a single-acting engine without a flywheel makes more irregularity in the flow of the water in the main than the erank motion does; then if the crank engine works double-acting, the flow of the water is of course much more regular; and when, in addition to this, a pair of such engines are coupled at right angles, the flow is so nearly regular that the ordinary air vessel makes it practically uniform. This is shown by the diagrams represented in Figs. 9, 10, and 11, Plate cxxvii. Fig. 9 shows the variation in the velocity or flow of the water from a single-acting engine without a flywheel, the dotted line repre-

* Read before the Institution of Mechanical Engineers.

senting the mean velocity.* Fig. 10 shows the variation in the velocity of the water from a double-acting engine controlled by a flywheel, the straight dotted line representing the mean velocity; and the inverted dotted line shows the corresponding velocity of the water from a second double-acting engine working at right angles to the former one. And when these two are coupled together, as in Fig. 20, the result is seen to be a very slight deviation from the mean line, or, in other words, a very regular flow of water. It should also be observed that a pair of engines so arranged make many more strokes per minute than it is possible for an engine without a flywheel to do, and this again is another cause of the greater regularity of flow; and now that waterworks companies are more enterprising than formerly, and pump the water often to six, eight, or ten miles distance, regularity in the flow is a most important point, independent of any question of greater security with the mains, which are not so liable to burst or leak in consequence of the jerking of the water at each stroke of the engine. There is also some considerable advantage in having a pair of engines in place of only one, since necessary repairs can be better executed by stopping one and letting the other continue to do its half of the work.

It may not be out of place here to remark upon the great advantage obtained in all beam engines working expansively from the inertia and momentum of the beam, particularly where the beam is made heavy, as it should always be in such cases; it then acts precisely in the same manner as the balance bob. With a view of effecting this object to a still greater extent, the author many years ago designed a plan of fixing a top weight on to the beam of an engine, at some height above the main bearings; so that not only should its inertia and momentum come into play, but its weight also should be lifted by the steam at the commencement of the stroke, and by its descent in the latter part of the stroke should again give out the force so absorbed; this would help many an engine that had not in the first instance been properly designed for much expansion, but in which expansion had been subsequently introduced. This arrangement is shown in the diagram Fig. 5, Plate cxxvii., in which it will be seen that the weight will have to be lifted by the steam during the first half of the stroke, the force required being greatest at the commencement of the stroke, where the leverage of the weight is greatest; in the latter half of the stroke the effect of the weight will gradually increase in the reverse order.

In horizontal pumping engines there is one great advantage which makes them particularly applicable for certain situations—namely, that they require no large and massive engine-house to form part of the construction; indeed the "heavy castles" that used to be required to carry beams and spring beams, &c., and so form part of the engine, are not required at all for horizontal engines. When these are properly constructed, so that the strains between the pumps, steam cylinders, and crank-shaft, are taken by the iron frame or bed-plate itself, all that is required is a horizontal foundation for a pair of engines to be fixed on, with a well in the middle for the air-pumps and condensers, &c.

In the present paper are described two constructions of horizontal pumping engines designed by the author for pumping water at the Crystal Palace and at the Yarmouth Waterworks; the former having been started early in 1854, and the latter in May, 1855.

Fig. 1, Plate cxxvii., is a longitudinal section of one of the two pair of engines at the Crystal Palace. The steam cylinders, A, Fig. 1, are $35\frac{1}{2}$ in. diameter by 36 in. stroke, and the pumps, B, are the same stroke and $21\frac{1}{2}$ in. diameter; these are double-acting and placed horizontally, the bucket rods, C, being connected direct to the steam pistons by being keyed into the same crossheads, D, which work in horizontal guides, E, in the frames, F. A long forked connecting rod, G, is attached to the ends of the crosshead, D, and extends to the crank on the flywheel shaft, H, beyond the pump, the two engines being coupled at right angles. The flywheel, I, is 14 ft. diameter, and runs between the two engine frames, F. Each frame is cast in one piece, in the form of a pair of longitudinal girders connected by cross girders; and upon this the steam cylinder, A, and pump, B, are fixed in a direct line, as shown in the plan Fig. 3, Plate cxxvii., which represents an adjoining pair of engines, the same in general construction, only differing a little in dimensions from those shown in Fig. 1; an inner girder underneath is prolonged to carry the crank plummer blocks. The air pump, K, of the engine is placed vertically below, and worked by bell-crank levers, L, connected by links to the crosshead, D, the stroke being half that of the steam piston. The air pump is 22 in. diameter, and the bucket and delivery valves, M, are india-rubber discs on gun metal grids; there is no foot valve, the bucket dipping at each stroke into a well sunk in the bottom of the condenser, N. The injection is admitted by a conical valve, O, in the centre of the bottom of the condenser, lifted by a regulating screw. The cold water pump, P, is worked from the opposite end of the bell-crank levers, L, and its valves are india-rubber discs on brass grids.

The main pumps, B, are of cast-iron, bored out and lined with gun metal $\frac{3}{8}$ in. thick. The suction valves, R, are in chambers underneath the pumps at each end, and the delivery valves, S, in chambers on the top of the pumps at each end; they discharge into an air vessel, T, fixed over them, consisting of a horizontal cylinder with hemispherical ends, 3 ft. 9 in. diameter and 8 ft. 3 in. length. A glass water guage, U, at the end of the air vessel shows the level of the water in it; and a small aircock is inserted in each suction pipe, V, for the purpose of drawing a little air continuously to keep up the due supply in the air vessel. The delivery main, W, is carried down from the centre of each air vessel, the two mains uniting in the centre between the engines, as shown in Figs. 3 and 4, Plate cxxvii., and forming a single large delivery main, X. A stop-back valve is provided to the delivery main, W, of each engine.

CRYSTAL PALACE ENGINES.

Fig. 12.—Vertical Section.

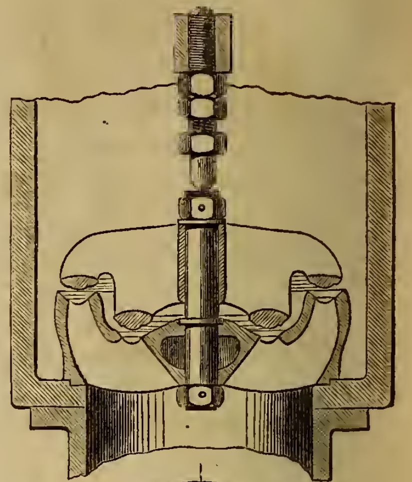


Fig. 13.—Plan.

The pump valves, R and S, are shown enlarged in Figs. 12 and 13 (woodcut). They are ring valves of peculiar construction, and the seats have two annular openings, 1 in. wide each, for the passage of the water, the lower annular opening being 7 in. mean diameter and the upper one 13 in. diameter. The valve and seat are both of gun metal, and the valve is guided by sliding on a fixed centre pin. The area of the two annular openings of the seating is 63 square in., and a lift of $\frac{9}{16}$ in. is sufficient to give an equal area of passage for the water. This form of valve has the advantage of giving four openings for discharge, being at both the inner and the outer edges of each of the openings in the seating. The weight of the valve is 37 lbs., which gives a pressure of 59 lbs. per square in. as the force required upon the area of opening for lifting the valve and holding it open, being equivalent to about 16 in. additional head of water. The weight of the valve is adjusted so that the velocity with which the water passes it, when open, shall not cause sufficient pressure to force it up against the stop; and the consequence is that the

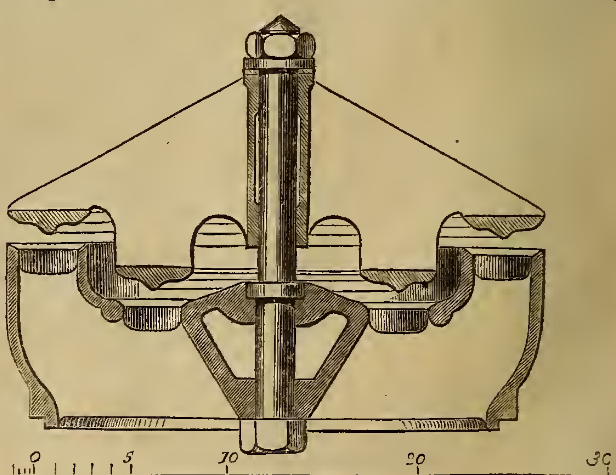


Fig. 14.

Berlin Waterworks.—Vertical Section.

* The curve shown in Fig. 9 has been constructed from the actual velocities ascertained in experiments made by a Committee of the British Association with the Author's father, the late Professor Cowper, upon the Cornish pumping engine erected by Mr. Wicksteed at the East London Waterworks, Old Ford.

CRYSTAL PALACE PUMPING ENGINES.

Fig. 15.—Diagram of Lift of Valve traced by the valve itself.—Vertical Scale full size.

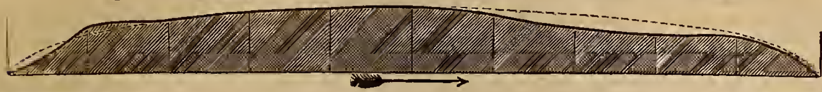


Fig. 16.—Section of Slide Valve in middle position.—Scale 1-10th.

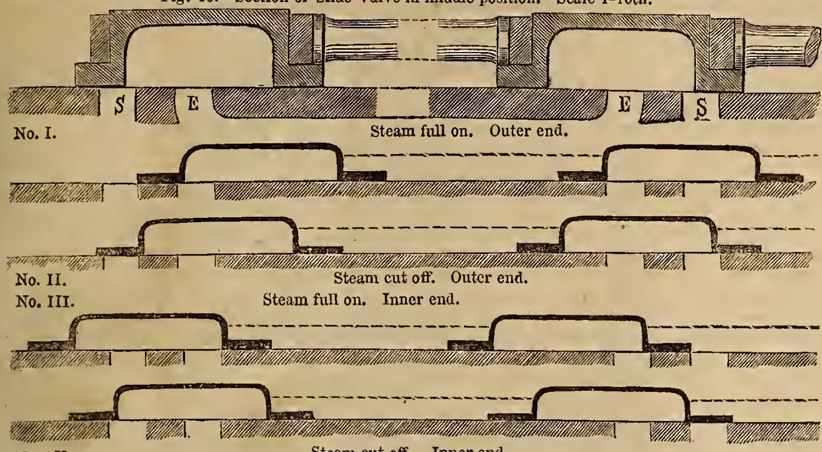
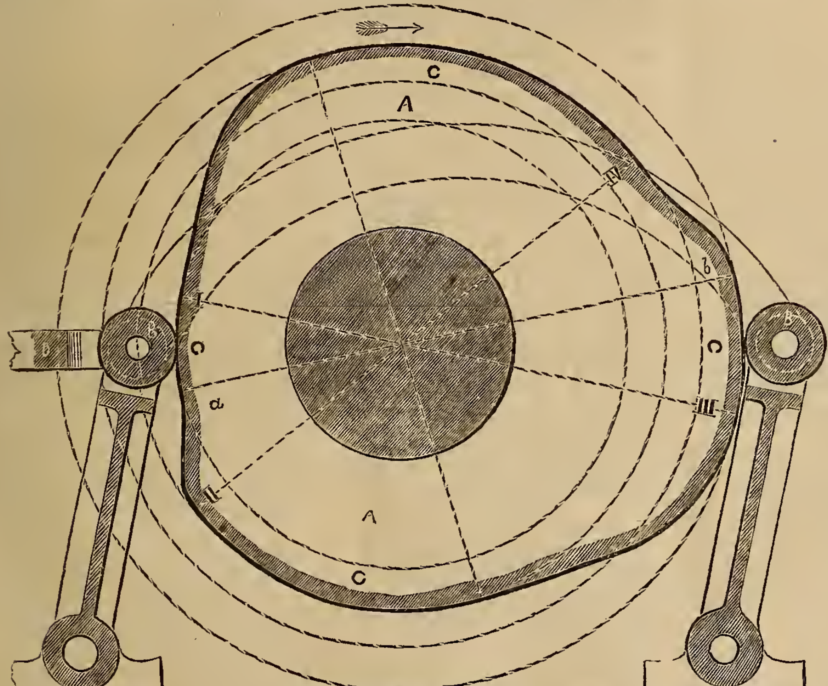


Fig. 17.—Side Elevation of Cam for Working Slide Valve.



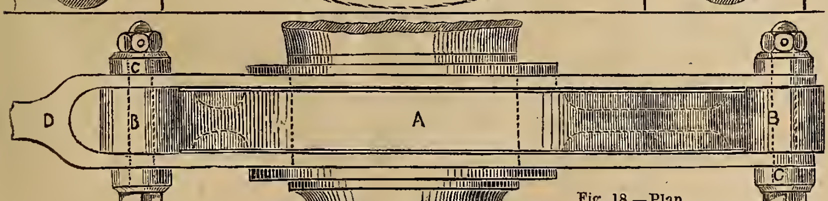
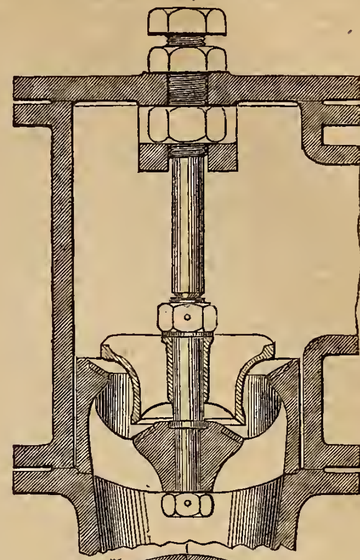


Fig. 18.—Plan. Scale 1-10th.

Fig. 22.—Section of Slide Valve of Yarmouth Waterworks Pumping Engines. Scale 1-10th.

YARMOUTH WATERWORKS.

Fig. 20.—Vertical Section.



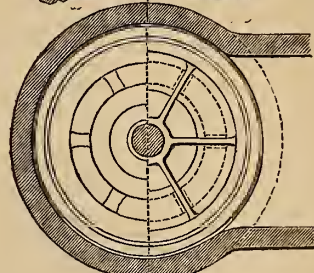


Fig. 21.—Plan.

valve is always pressing steadily upon the water as if floating closely upon it, and shuts gradually without shock, as the upward motion of the water diminishes and ceases under the control of the crank. A similar valve designed by the author for a friend, and in use at the Berlin Waterworks, is shown in Fig. 14 (woodcut); many other valves have also been made of this form, and all are working well. Fig. 11 is a diagram of the lift of the valve at the Berlin Waterworks traced by the valve itself in actual working; the line was drawn on a sheet of paper moved horizontally by direct connexion with the piston rod, and the vertical dimensions in the diagram Fig. 15 (woodcut) are full size; the dotted line shows the theoretical lift of the valve as set out on the motion of the piston, that is, on a line representing uniform division of space, showing the lift of the valve or proportionate area of opening required at each point of the stroke in order to maintain a uniform velocity of the water through the valve. From this it will be seen how very close the valve is to its seat, before the crank actually passes the centre or the motion of the piston is reversed; so that it is clear that with a crank engine, having valves with a low lift and always floating on the water, there can hardly be any blow whatever at the turn of the stroke.

The regular speed of the engines is 15 revolutions per minute, giving a mean velocity for the pistons of the engines and pumps of 90 ft. per minute, and a total delivery of 2,827 gallons per minute from each pair, or 5,654 gallons per minute from the two pair. These engines and pumps are employed to raise the water from the lower reservoir or lake to the upper open reservoir in the grounds of the Crystal Palace, having a head of about 103 ft., for the purpose of supplying the intermediate fountains; they are fixed close to the lower reservoir, having only a short length of culvert and suction pipes. Another pair of pumping engines shown in the plan Fig. 3, Plate cxxvii., of similar construction, only differing a little in dimensions, are placed at the lower level for sup-

plying this lower reservoir; they are fixed at a low part of the grounds, about 20 ft. below the level of the lake from which they draw, in order that they may be out of sight. The suction pipe in this case is of great length, about 900 ft.; and for the purpose of avoiding the objectionable shock that would have arisen from the alternation in velocity of this long column of water, a large "stand-pipe," Y, Figs. 3 and 4, is fixed at the end of the suction pipes, close to the pumps. This stand-pipe is a rectangular cast-iron tank, 7 ft. 4 in. long by 2 ft. 4 in. wide and 22 ft. high, with the two suction pipes entering on one side at the bottom, after passing and being connected to the vertical suction pipes, V, of the pumps. A slight rise and fall only in the level of the water in the stand-pipe occurs at each stroke of the pumps, in consequence of the slight change in the velocity at which the water is taken off by the pumps; and a uniform motion of the water through the long suction-main is thereby preserved. These engines were constructed by the late firm of Messrs. Cox and Wilson, of Oldbury.

In Fig. 6, Plate cxxvii., is given the indicator diagram from the Crystal Palace pumping-engines, showing the mean line during five minutes' regular working, the extent of variation being included in the thickness of the line. The steam is admitted at a pressure of 18·0 lbs. per inch above the atmosphere, cut off at 1-3rd of the stroke, and expanded down to 5·8 lbs. below the atmosphere at 1-20th from the end of the stroke, giving a mean steam pressure of 5·76 lbs. above the atmosphere; the mean vacuum is 12·44 lbs. below the atmosphere, beginning at 11·8 lbs. at 1-20th of the stroke, and ending at 13·0 lbs. The total mean pressure is therefore 18·20 lbs. per inch, giving 49·1 indicated H.P. for the pair of engines at the speed of 15 revolutions per minute. This gives 89 per cent. as the useful effect.

The slide valves in these engines are single slide valves, as shown in section in Fig. 16 (woodcut), which represents the valve in its middle position, SS being the steam-ports and E the exhaust. The valves are worked by a cam motion, which is shown in Figs. 17 and 18 (woodcut). The cam, A, works between two rollers, BB, carried by two vertical rocking levers, CC, which are linked together at the top by means of the curved and forked end of the horizontal valve rod, D; the diameter across the cam is made the same in all positions, so that both rollers are constantly in contact with it, or, in other words, it "fits and fills." The outline of the cam is made of such a shape as to hold the valve stationary in four positions in each revolution, as shown in the Diagrams Nos. I., II., III., and IV.; and it will be observed that the valve stands still in these positions half the total time of each revolution. The whole travel of the valve is 6¼ in.; it is moved first 2¼ in. from its extreme position, from No. I. to No. II. (or No. III. to No. IV.), to cut off the steam at 1-3rd of the stroke of the piston, and then remains stationary with the exhaust 1½ inch open until close to the end of the stroke, when the valve is moved the remaining 4 inches of its travel, from No. II. to No. III. (or No. IV. to No. I.), thereby opening the exhaust and opening the opposite port to the steam. The steam-ports, S, are 2 in. wide by 10 in. long, and the valve has 1⅛ in. lap at each end, as shown in Fig. 14, whilst the inside is open 5-8ths in. to each port at each end at one instant of time; that is to say, it is 1¼ in. longer inside than the distance between the ports, as shown in Fig. 16.

The curves of the cam are arranged so as to move the valve at each portion of its travel with a *uniformly accelerated* motion during the first half of each movement, and a *uniformly retarded* motion during the latter half, so that it is started gradually from a state of rest, as in the commencement of motion of a falling body, and then as gradually stopped again; and the speed of the motion being so much less than the velocity acquired by a falling body in the same time, the pressure required to produce the motion amounts to only about one-fourth of the weight of the moving parts. The shorter movement of the valve is made in 27° of a revolution, and the longer movement in 62° of a revolution.

There is an arrangement in the cam rod by which, at the time of starting the engine, the cotters at the end of the rod can be drawn up, and so leave the rod free to move to the extent of 1 in., that is with ½ in. play each way: by this means, when the cam rod moves, the valve rod is left behind ½ in., which leaves the steam on throughout the stroke by failing to cut it off entirely, so that the engine is started without expansion, although the opening of the port is small after the cam rod has moved to cut off the steam.

This valve motion the Author has found to work with complete success; and whilst great economy of steam is obtained, the expense of a separate expansion valve is avoided; but in cases of very quick running engines the cam motion might be objectionable. He has obtained a very good result with an ordinary eccentric and slide valve, arranged to cut off well at half stroke, by modifying the interior of the valve; making the inside opening considerably greater than the space between the ports, so that one port is opened one-fourth, or even one-half, to the exhaust, before the exhaust from the other port has closed. A valve of this form is shown in Fig. 19, Plate cxxvii., with the accompanying indicator diagram, Fig. 8, Plate cxxvii., taken from it with a non-condensing engine. In this case the steam is cut off at half stroke, and although the exhaust is opened early, the line of the figure drops very little below the full expansion line; and the advantage is gained of a good exhaust at the commencement of the return stroke, with small amount of compression at the end, the mean back pressure being only 0·91 lbs. There exists, therefore, no reason why the very cheapest high pressure engines should not be made to work expansively, by cutting off at half stroke, or a little later, according to circumstances; and, in fact, almost any high pressure engine could be altered to do so.

Fig. 2, Plate cxxvii., is a longitudinal section of the pair of pumping engines at the Yarmouth Waterworks; and Fig. 5, Plate cxxvii., is a general plan to a smaller scale. These engines are employed for forcing the water to a high level reservoir at a distance of several miles; they are nearly similar in construction to those previously described, with the addition of a low-lift pump, P, fixed vertically under each engine, employed to pump the water from the well under the engine, which is supplied with water from a collecting reservoir (Ormsby Broad) on to a set of filter beds. These pumps, P, are 18¾ in. diameter with 18 in. stroke, and are worked from the opposite end of the bell-crank levers, L, that work the air pumps, K, of the engines; the height of lift is only 20 ft. As these low-lift pumps are only single-acting plunger pumps, the plungers are loaded so as to equal nearly half the head of water; thus half the work is done when the plunger is rising.

The steam cylinders, A, are 24 in. diameter, with 36 in. stroke, and the high-lift pumps, B, worked from the same piston rod, are 9 in. diameter, with 36 in. stroke. A forked connecting rod, G, is carried from the crosshead, D, to the crank, H, and the flywheel, I, 12 ft. diameter, works between the two horizontal frames, F, of the engine. The high-lift pumps, B, are supplied with filtered water by a main, V, Fig. 5, from the filter beds; and as there is some head of water on them, a stand-pipe, Y, is arranged on the end of the main, V, to allow of a slight fluctuation of the level of the water, due to the small variation in the rate at which the pumps take the water. Two cast iron girders under the frame of each engine span across the well, thus making a continuous foundation for the engine frame to lie on; the two inside girders are continued to carry the crank plummer blocks.

The pump valves are shown enlarged in Figs. 20 and 21 (woodcut). They are of gun metal, with a seat of cast iron faced with gun metal, and are double-beat valves, having the small seat at the bottom, instead of at the top; this allows of a central pin to act as a guide, and is so far a great advantage, as there is no danger of the valve hanging or sticking when it ought to follow the water freely. This form of valve was used at some waterworks under Mr. James Simpson, some years ago, and the Author believes was designed by Mr. A. Slate. The valves have two bearing faces, 5 in. and 8¼ in. inside diameter, with a vertical lift of 11-16th in. The total area for pressure is 26·3 sq. in., and the weight of the valve is 18 lbs., requiring a pressure of ·68 lbs. per square inch to hold the valve open, equivalent to an extra head of water column of 19 in.

The regular speed of the engines is thirty revolutions per minute, giving a velocity of the pump piston of 180 ft. per minute. The height to which the water is pumped is 160 ft., including the friction of the mains.

The boilers, of which there are three, consist of a cylindrical shell, 6 ft. diameter and 20 ft. long, with two fire tubes 2 ft. 3 in. diameter; the flues returning outside along the sides of the boiler, and passing to the chimney along the bottom. By firing the two flues alternately, and by the admission of air at the bridge, the prevention of smoke is found to be practically effected.

These engines are required to be worked at present only one day at a time twice per week, and the consumption of coal is consequently higher than it would be in constant work, from the brickwork, &c. never getting properly hot. The consumption per hour, exclusive of getting up steam, is found to be 224 lbs., and the effective duty of the pumps being 56·74 H.P., the consumption of fuel amounts to 3.94 lbs. per H.P. per hour on the net work done. The whole of the Yarmouth Waterworks, where these engines are situated, were designed and carried out by Mr. J. G. Lynde, one of the members of the Institution; Messrs. Cochrane and Co. were the contractors for the pipes and engines, which latter were constructed by Messrs. Cox and Wilson, as sub-contractors, and the details and drawings were arranged by the Author.

The indicator figure from these engines in ordinary work is shown by the shaded area in Fig. 7, Plate cxxvii. The steam is admitted at a pressure of 9·0 lbs. per in. above the atmosphere, cut off at 1-3rd of the stroke, and expanded down to 7·0 lbs. below the atmosphere at 1-20th from the end of the stroke, giving a mean steam pressure of 1·05 lbs. above the atmosphere; the mean vacuum is 13·17 lbs. below the atmosphere, beginning at 12·5 lbs. at 1-20th of the stroke, and ending at 13·6 lbs. The total mean pressure is therefore 14·22 lbs. per in., giving 70 indicated H.P. for the pair of engines at the speed of 30 revolutions per minute. This gives 81 per cent. as the net useful effect, exclusive of the friction of the engines and pumps. The upper full line in Fig. 7 was obtained by shutting off the steam partly from one of the engines, and putting most of the work on the engine from which the diagram was being taken; the mean steam pressure is 6·38 lbs. per in., and the

mean vacuum 11·66 lbs., making a total mean pressure of 18·04 lbs. per inch. The dotted line shows the indicator diagram when the high-lift pump was detached, and only the low-lift pump worked; the mean total pressure is 2·44 lbs. per in.

The slide valves shown in Fig. 22 (woodcut), consist of first the ordinary working slides A, driven by an eccentric, and secondly the expansion slides B, on the back of the working slides A, driven by another eccentric, so that the steam is cut off very close to the cylinder. The expansion slides B can be thrown out of gear to start with, but this is not found to be really necessary.

It must not be supposed that horizontal pumping engines are the most suitable for all situations, as, for instance, in the case of deep wells; but there are very many cases, particularly for waterworks, for which they are particularly applicable. In conclusion it should be stated, that the engines described above are not brought forward as containing any very novel invention; but are simply described as works that have been executed, and that have answered the purpose for which they were designed.

To be continued.

ON OIL MILL MACHINERY.

By Alexander Samuelson, Mem. Inst. M.E.

Read at the Meeting of the Institution of Mechanical Engineers, at Birmingham, 28th January, 1858.

Joseph Whitworth, Esq., President, in the Chair.

(Continued from page 166).

The following are the comparative results of the stampers and the hydraulic presses in the above works, the area of floor upon which the machinery stands being the same in both cases, 121 ft. by 30 ft. With the twelve stampers previously employed the largest quantity crushed in one year (day work only) was 13,000 quarters of seed; but with eight hydraulic presses working day and night they have worked 52,000 quarters, which would be equivalent to about 30,000 quarters for day work only; and with ten hydraulic presses, which now form their complement, they will crush 65,000 quarters of seed, working day and night. Then with the stampers they were compelled to work the seed twice over, whereas with the hydraulic presses it is only necessary to work it once, in both instances yielding the same quantity of oil; and the consequent saving of labour is equivalent to from 20 to 25 per cent. The difference in point of wear and tear between the two modes of crushing is found to be considerably in favour of the hydraulic presses, while the cost of wedges with the stampers was very considerable, and altogether there is an important saving in the new method. As to the comparative amount of power required, there is found to be a large saving in favour of the hydraulic presses.

The practical conclusions from the results of working appear, then, to be—that in the same sized mill the hydraulic presses produce about three times as much oil as the stampers; that they do this with less wear and tear, and at a considerable saving of labour, since the seed has only to be handled once; and that the general expenses in working the hydraulic mill, as compared with the stamper, owing to the increased production, are much less per quarter of seed crushed; for the consumption of coal, general charges, and interest on plant, &c., will be the same whether 13,000 quarters per annum are crushed by the stampers, or three times that quantity by the hydraulic presses.

In conclusion, it may be interesting to give some particulars as to the extent of this manufacture. It appears from the official returns that the quantity of seed imported into this country for the oil manufacture was 364,000 quarters in 1841, increasing in ten years to 630,000 quarters in 1851, and amounting in 1856 to about 1,100,000 quarters, the last amount producing about 144,000 tons' weight of cake, and 56,000 tons of oil.

The cake is used for feeding cattle, and the oil is used chiefly for painting, and a very large portion is again exported. The immense increase, however, in the quantity of cake produced shows either that there are more cattle fed upon it in this country than there were a few years ago, or that a much larger quantity of cake is consumed per head of cattle than used to be. It is difficult to ascertain correctly in which respect the greatest increase has taken place; but the increased consumption of cake may probably be attributed rather to the more general adoption of feeding cattle on linseed cake.

It appears that to crush the seed imported in 1856 there were required about 150 to 160 double hydraulic presses at work day and night; nearly 100 of these are at work in Hull, and the rest are distributed all over the country, the more important mills being in London, Liverpool, Grimsby, &c.

It is on account of the prominent position that the town in which the writer resides holds in the manufacture described in this Paper that he has offered these particulars, responding to the call of the Council for a Paper on this subject amongst the list of subjects for Papers; and he will be happy to afford any further information to the Institution that may be desired.

Discussion.

Mr. A. Samuelson exhibited specimens of the seed from the several processes described in the Paper, and a model of the large oil mill at the Isle of Dogs that had been referred to, which consisted of three complete compartments, each containing two double hydraulic presses, with a pair of edge stones and rollers, all driven by steam power, the several portions of the mill being connected by friction couplings. He remarked that one other point to be noticed, in reference to the superiority of the hydraulic press and stamper as compared with the screw press, was that it was found by seed crushers that a slight rebound of the press after each increase of the pressure applied was advantageous, allowing the oil expressed from the seed to escape more readily; the stamper recoiled after each blow, and was liked on that account, and, in fact, the ram of the hydraulic press also accomplished the same object by recoiling slightly between each stroke of the pump, the pump being single-acting; but with the screw press there was no part of the apparatus that could give way in this manner. A great point in oil manufacture consisted in bruising the seed well between the rollers before applying the pressure in the final process; and there was more importance in that than in any other operation, as the oil was thereby expressed much more freely and thoroughly.

Mr. B. Fothergill asked whether the rollers were covered with any hard and durable material.

Mr. A. Samuelson replied that the rollers were not covered, but merely hard cast iron, which was found sufficiently durable for the work. A beneficial effect as regarded the working of the rollers was also found, owing to a small amount of slip arising with rollers of unequal diameters. The smaller roller lagging behind a little, being driven only by friction through the medium of the intervening seed, gave a slight cutting or grinding action, which greatly increased their efficacy in crushing the seed, and experience had resulted in the adoption of rollers of 4 ft. and 1 ft. diameter, as shown in the drawing.

The Chairman inquired how often the rollers required to be turned up to ensure a sufficiently even face for crushing the seed in the most effectual manner.

Mr. A. Samuelson said the durability of the rollers varied with the quality of the seed to be crushed and the hardness of the metal. They worked for 12 or 18 months generally without requiring to be turned up, but sometimes for only 2 or 3 months. They were made of cast iron, about as hard as could be conveniently turned, though, probably, not quite so hard as the plate rolls used in ironworks.

Mr. J. E. McConnell asked what was the speed at which the surface of the rollers worked.

Mr. A. Samuelson replied that the large roller, 4 ft. diameter, was driven at about 56 revolutions per minute, giving a speed at the circumference of the two rollers of about 700 ft. per minute.

Mr. B. Fothergill considered the Paper that had been read was a very valuable one, and of great practical interest. It was a kind of paper particularly serviceable to the Institution, giving the practical results obtained from long experience, and they were much indebted to Mr. Samuelson for the great trouble and care he had bestowed upon its preparation. It brought forward clearly in one view the whole history of the process of seed crushing, showing what had been the early plans, with the successive improvements that had been effected up to the introduction of the modern machinery used in oil mills. Some of the primitive contrivances for expressing the oil evinced considerable ingenuity and mechanical skill on the part of the early inventors, although without any previous example to guide them. It was particularly interesting to see to what an extent economy of time and labour had been kept in view, as in the case of the early press that had been noticed as invented by Mr. Hebert, which was certainly very simple in construction and action, and had an advantage in saving of labour and of unnecessary dead weights; the workman himself acting as the weight for expressing the oil by raising himself into the scale suspended from the end of the horizontal lever, as soon as he had placed the seed bags in the press, and thus no time was lost in the process. One name was pointed out for special notice by the history of the contrivances adopted for expressing the oil—namely, that of Bramah, who appeared both to have the merit of the first contrivance for screw propulsion, now coming into such universal use, and also by the invention of the hydraulic press to have superseded all other appliances for expressing oil, and supplied the most important, powerful, and universally applicable means that existed for applying great pressure.

Mr. Sampson Lloyd asked whether any adaptation of the hydraulic press had been attempted for expressing oil from other seeds, as well as linseed.

Mr. A. Samuelson said the hydraulic press was applicable for all seeds, and also for nuts containing oil, such as the cocoa-nut; but in some few seeds, such as rape seed, a preliminary process called "clodding" was found necessary, in which the seed was made into a sort of pulp in extracting the first portion of the oil. In expressing the oil from rape seed many seed crushers reserved one of the old stampers for clodding the seed before submitting it to the final pressing by the hydraulic press, the seed being thus worked twice over so as to express the oil more thoroughly.

Mr. P. D. Bennett observed that a similar principle was applied to malt crushing and splitting beans.

Mr. R. Williams asked whether the hydraulic presses were always placed vertically, as there appeared to be some disadvantage in that arrangement from the greater height of lift to the upper portion of the work.

Mr. A. Samuelson replied that the presses were always placed vertical in this country, and the question of their arrangement had been very closely gone into in America, where horizontal presses had been tried for the purpose of placing the bags in them more quickly and easily; but it was found that the oil could not be collected so well as in the vertical presses with vertical piping, and the hair bags were subjected to wear at the bottom, as they had to slide horizontally along the bottom of the press. The only advantage in the horizontal presses was that all the bags were reached at the same level; but this was not a point of much importance, as they could easily be lifted up in the vertical presses, and there was only a moderate height to reach. A press had been designed by Mr. Bodmer, provided with a quadrant, by which it could be laid down for placing the bags in it and raised up again for compressing the seed; but it was evident that such a plan would involve a great loss of power and time in raising and lowering the press, and the vertical press described in the Paper was the one that had proved most practically successful.

Mr. E. A. Cowper asked whether any plan had been tried for keeping the seed hot whilst in the presses, by placing it in hollow boxes heated by steam, which had been attempted in some French presses for other purposes.

Mr. A. Samuelson said that plan had been employed in making stearine and in other manufactures where it was important to keep up the temperature in order to preserve fluidity, but he believed it had not been tried in oil mills; it might be effected with no difference except the use of hollow boxes and flexible steam pipes, but he thought the additional heat was not of so much importance in expressing oil as to be worth the additional complication.

Mr. E. A. Cowper enquired whether the edge stones used for grinding the seed were shod with iron to make them more durable.

Mr. A. Samuelson replied that the edge stones were not shod, but were made of Derbyshire stone, which was very hard and worked well without much wear. Aberdeen granite had been previously tried, but was found to get smooth and slip after working for a short time.

The Chairman asked what increased durability there was found to be in the hydraulic presses by working them with oil instead of water.

Mr. A. Samuelson said the cupped leathers for packing the rams lasted longer when the presses were worked with oil, and there was no perceptible wear of the rams; but with water they were liable to cut, in consequence of small particles of grit being carried in with the water, and some corrosion of the iron taking place.

Mr. E. A. Cowper asked how the safety valves of the hydraulic presses were arranged so as to blow off always at exactly the fixed pressure; there was sometimes a difficulty in this when the area of the valve was very small and the pressure great, and he had known of an instance in which the press had been burst in consequence of the valve being so well ground into its seat as to fit tight at the lower edge, which materially increased the load per square inch on a valve of so small an area. He had adopted a plan for meeting the difficulty by making the seating of the valve truly conical, but giving the valve itself a slightly rounded or curved face, so that the effective area of pressure was kept constant, the valve being in contact with the seating only at one part.

Mr. A. Samuelson said the safety valves used in oil presses were conical brass valves, about 1 in. or $1\frac{1}{4}$ in. long, about 9-16th in. diameter, and about 3-16 in. diameter in the seat, tapered so as to leave very little margin for irregularity of pressure. There was generally, however, very little action of the safety valves, as the workmen soon got to know when the oil was completely expressed.

INSTITUTION OF CIVIL ENGINEERS.

May 11th, 1858.

Joseph Locke, Esq., M.P., President, in the chair.

The discussion upon General Tremenheere's Paper On Public Works in the Bengal Presidency was continued throughout the evening.

In commencing the discussion, it was explained that, although the subject of railways in India was brought forward in the year 1843, and a short experimental line, about 140 miles in length, from Calcutta to Raneegunge, was sanctioned by the Government in 1849—which was, however, only opened in February, 1855—yet it was not until 1853, during Lord Dalhousie's administration, that the three main trunk lines now in course of construction were projected. These lines extended from Calcutta to Lahore, from Bombay to Madras and to join the Calcutta line, and from Madras to the West Coast.

It was observed, that the history of the introduction of railways in Western India, which was given in detail, showed that the Bombay Presidency took the lead in the inauguration of that kind of communication; the first section of the Bombay Railway having been opened for traffic a year and a half before the first section of the Calcutta line. It appeared that in 1843, Mr. Clerk proposed a railway named the Great Eastern, for extending communication from Bombay to the country behind the Ghauts, to the north-east and south-east. About the same time, Mr. Chapman projected the Great Indian Peninsular Railway, which was originally designed for the whole of India. Subsequently, a coalition took place between the two companies; but it soon became evident that Bengal and Madras would each be granted an independent system of their own. The scope of the undertaking was, consequently, reduced from that of a system intended to suffice the railway requirements of the entire Peninsula, to that of one aiming only to draw into the harbour of Bombay the produce of so much of the back country as could be brought within a remunerative distance by means of the railway. During the years 1846 and 1847, the surveys, reconnaissances, and collection of traffic statistics, were proceeded with, and the following year was occupied in the obtainment of the Government guarantee. The subsequent delays had arisen from a military man having been appointed by the Government their consulting engineer, who laid it down as a rule that no gradient steeper than one in two thousand should be adopted on a trunk line. This had, however, been overruled, and the ascent of the Bhore Ghaut, on the Bombay line, which was now nearly complete, was the grandest example of mountain railway engineering yet attempted.

It was stated that the Ganges Canal and the Grand Trunk Road were the only public works worth mentioning in the Bengal Presidency; such works being the rare exception, and not the rule. This did not compare favourably with the 36,000 miles of railway, and efficient and extensive system of inland navigation, carried out by private enterprise during the last twenty-five years in the United States of America. The funds appropriated to public work extension in India had hitherto not been equal to the requirements of so vast and so roadless a country; and, owing to a want of any comprehensive plan, to a defective system of administration, and to inappropriate agencies, the sums expended had not, in the aggregate, been productive of any commensurate commercial benefit. The expenditure for public works in the Bombay Presidency for the last twenty years was cited as an example. It was believed that the public works of India could never be carried on economically, on the necessary scale and at the required speed, until the conduct of such undertakings was entrusted entirely to civil engineers—until private enterprise was llowed freer scope than it had hitherto had, and until the advantages incidental to the development the contract system had attained in England were more generally appreciated and realised in our Indian possessions.

It was contended that the most important requirement of India, at the present time, was extended and improved means of communication between the different parts of the empire, both in the interior and on the sea-coast. To the westward of the Ganges this would be secured by the system of railways now constructing or projected; the upper branches and minor affluents of the Ganges and the Burhampooter being used as feeders. To the eastward, it was thought advantage should be taken of the natural facilities for water transport, aided by an improved system of steam-tug and tow-boats of native type, and capable of being navigated by native crews. It was remarked, that even the completion of the railways in the north-west was dependent on improved means of water transport. As Indian rivers were liable to be flooded at one season, and to be comparatively dry at others—a maximum draft of 2 ft. being all that could be depended upon—and as the alluvial soil of which the beds were composed was continually shifting, the system of water transport must be adapted to the variations of the depth and the character of the channel. It was a fallacy to suppose that light draft and capacity for cargo were only attainable by increasing the size of vessels. Such a system would lead to loss and disappointment. Where the draft was limited, the size, and consequently the weight, of the vessels must also be limited. What was required was a vessel combining the least draft of water with the greatest capability for dead-weight cargo. It was asserted that a train of four vessels, one tug and three tow boats, each 100 ft. in length and 15 ft. in breadth, had a greater capability for dead-weight, at light drafts, than the larger vessels in use on the Ganges and the Burhampooter. Indeed, these vessels had no capability for deadweight cargo at 2 ft. draft, and few of them had much at 3 ft. draft. The cost would also be less than a larger vessel of equal capability. It was true, that the trains of tug and tow boats could not, perhaps, compete in speed—but rapidity of transit was not necessary. The system of tug and tow boats was initiated by the Assam Company in 1841. They were connected together by a peculiar arrangement of the tug and tow post, having a radial spar attached to the tow ropes, which admitted of extension when required. The object of this arrangement was to give play to the balanced rudders with which the vessels were provided at the bow and the stern. This system had been proved to be so effective, that a vessel at full speed could be completely turned on her centre in fifteen seconds.

It was remarked that it would have been interesting to have been furnished with some details as to the rate of evaporation in the district traversed by the Ganges Canal. In this latitude, where the average temperature was 51°, only about one-third of the rainfall issued in springs, whilst two-thirds were lost by evaporation or other causes. To this it was replied that Colonel Baird Smith, in his work on Indian irrigation, had gone very fully into the question of loss by evaporation; and further, that owing to the abundance of water in that country, any loss of the kind referred to was, comparatively speaking, of no importance.

Great praise was undoubtedly due to the former rulers of India, as the remains of various public works fully testified that the ancient dynasties were not unmindful of the value of large irrigation works, which, though yielding no pecuniary return to the sovereigns, conferred incalculable benefit on the cultivators of the soil. The remains of roads had also been discovered, and a case was cited of a road from 60 ft. to 70 ft. in width, which had been embanked where necessary, was provided with rude bridges over water-ways, and was planted with rows of trees on each side; tanks of enormous size, now in a dilapidated state, with produce growing in the bottom, being also to be met with.

With regard to the river Damooda, it was stated that it was subject to excessive floods, which brought down an immense deposit. This gradually raised the bed of the river above the level of the surrounding country, so that the "bunds" or embankments required to be continually raised to prevent the water overflowing the adjacent land. The propriety of these embankments had been frequently discussed, but with no definite result. Indeed, one commission had reported in favour of retaining them, whilst another commission had urged their immediate removal. A middle course had been proposed—viz., to retain the "bunds" upon one side of the river, but that plan it was thought would be still more objectionable than either of the others. The "bunds" were sometimes destroyed by burrowing animals, and a great loss of life and property frequently ensued. Where no embankments existed, the flood-waters extended over a large area; and, provided the drainage channels were open, a submergence of three or four days was rather beneficial than otherwise to the rice crop; but if prolonged much beyond that time, the produce would be entirely destroyed.

Whilst the highest eulogium was passed on the Ganges and Jumna Canals, which were noble works, admirably designed and executed, it was regretted that they were almost the only civil works of any magnitude. As had been remarked in the Paper, money had always been forthcoming for purposes of war, but not for peaceful enterprises. The district and village roads were in a worse condition now than 100 years ago. This might partly be attributed to insufficient funds, and partly to the absence of that professiona direction and skill which were essential to their proper maintenance. It was stated that there were some stations on the East Indian Railway which were wholly inaccessible during a great part of the year; and it was undeniable that unless the small centres of commerce and civilization were connected with the main trunk railways, the latter would not prove so remunerative as they should be. It had been proposed to construct a number of local branch railways, somewhat on the American plan; but it was argued, looking at the vast extent of territory to be accommodated, that the outlay for a comprehensive system would be enormous, and that improved district roads were what was first required. It had been said at one time that, since produce could be carried so cheaply—about five farthings per ton per mile—and since the nature of the country was such for agricultural purposes that, during the rainy season, there was nothing to be carried, whilst in the dry season the ground was so

hard that it might be traversed in any direction, there was no necessity for roads, as it was an export trade that alone had to be looked to. But, it must be remembered, that periods of famine occurred in some districts, when it was of the highest importance that there should be improved means of inter-communication.

As the idea seemed to be entertained that the works on the East Indian Railway were light, it was stated that the earthworks averaged 120,000 cubic yards per mile, and the masonry 4,000 cubic yards per mile. Railway works in India would take longer to construct than in this country, owing to the materials and appliances having all to be assembled on the spot by the engineering staff, as well as to the great want of subordinate agents and inspectors, and the scarcity of labour of all kinds, particularly of skilled labour, which in fact had to be created and taught. This was one of the principal difficulties in the prosecution of public works in that country. To this it was replied, that engineers had had to contend with the same circumstances at home, and that a new country could not expect to start where the old one left off. It must necessarily pass through the same gradations, and so far from being a disadvantage, it afforded an admirable field for the exercise of professional skill and ability.

It had been said that it would be preferable if railway works in India were carried on by private enterprise. This was doubtless correct in principle, where practicable; but if English capitalists would not embark money in such enterprises without a government guarantee, it was a necessity of the case, that some supervision should be exercised to see that the money was properly expended. Difficulties had arisen in consequence of this, because it so happened that the supervision had been carried on by gentlemen of the highest intelligence and skill, but wanting in practical knowledge and experience of the peculiar works: in fact, it was probable that they might never have seen a railway. It was suggested that the Indian government should send to each Presidency an able and experienced man, practically conversant with English railways, and then it was believed the system would be as perfect as in this country.

NOTICES TO CORRESPONDENTS.

We regret that, in consequence of the length to which several important articles in the present Number have extended, several other articles and communications of interest, and also letters from D., R. S. T., C. A. (Woolwich), G. J. Y., R. A., and others, although set up, must stand over until next month. For the same reason also we regret that we are obliged to omit two pages of Reviews and Notices of New Books, &c.; and for like reason—want of space this month—we have had to omit several rather lengthy replies to correspondents who have not favoured us with their addresses; to such of them as have, we have addressed them by post, with two exceptions; those will be replied to as early in the month of August as possible.

ERRATUM.—Page 156, 1st column, 15th line, for *yards* read *yarns*.

ON THE ASSAYING OF COALS BY THE BLOWPIPE.

By E. J. Chapman, Professor of Mineralogy and Geology, University College, Toronto. Read before the Canadian Institute, 16th January, 1858.*

The blowpipe had been employed with great success for nearly a century in the examination of minerals and chemical products, with a view to distinguish these numerous bodies from one another, and also to ascertain their general composition, when Edward Harkort, of Freiberg, first applied it to the quantitative investigation of certain silver ores and furnace products. Plattner, who had worked with Harkort, subsequently extended this application to the assaying of various metallic substances, and added, in no small degree, to the utility of the instrument by the invention of new methods of research, and many new appliances, published collectively in his well-known "Probirkunst mit dem Löthrohre.† No one, however, has yet attempted to employ the blowpipe in the practical examination of coals, an application peculiarly fitted to it, since, in travelling, and at other times when only the blow-pipe apparatus can be conveniently made use of, determinations of the kind in question are often desirable. Having had some experience in the use of the instrument, I have attempted to supply this deficiency; and thinking the subject of sufficient interest to be brought before the Canadian Institute, I have embodied, in the present paper, the results of my investigations. The subject may be conveniently considered under the following heads:—(1). Coal in its different aspects; (2). Instruments and appliances; (3). Operations.

§ 1. Different Varieties of Coal.

Without attending to minor distinctions or points of merely local value, we may arrange all varieties of coal, so far as regards practical purposes, under the following subdivisions:—

1. Anthracites.
2. Anthracitic or Dry Coals.
3. Caking or Fat Coals.
4. Cannel or Gas Coals.
5. Brown Coals or Lignites.

These varieties pass by almost insensible transitions into one another. Thus, the cannel coals are related to the lignites by the different kinds of jet, some of which are referable to the one, and some to the other subdivision. Between the caking and the cannel coals there are also various links; whilst the anthracitic or dry coals, on the other hand—passing by excess of bitumen into the caking coals, and by a diminution of bituminous matter into the anthracites—serve to connect the first and third divisions. The typical or normal specimens of each of these five varieties, however, are sufficiently well marked.

* From the "Canadian Journal."

† This work reached, in 1853, its fourth edition. Harkort's earlier publication (1827), of which, however, merely the first part was issued, bore a similar title. For all that concerns the history and general application of the blowpipe, the reader may consult the fourth edition of the standard work by Berzelius, as translated by Whitney. A new edition of this work, incorporating the various tests and discoveries published since the death of its distinguished author, is much required.

1. *Anthracites.*—The true or normal anthracites possess a brilliant sub-metallic lustre; a degree of hardness varying from 3·0 to 3·25,* and a specific gravity of at least 1·33. A specimen from Pennsylvania gave 1·51; another specimen, 1·44; one from the department of the Isère in France, 1·56; and three from Wales yielded respectively 1·33, 1·37, 1·34. It should be stated, however, that many of the Welsh specimens belong strictly to the division of anthracitic coals, rather than to that of the true anthracites. The normal anthracites exhibit also a black or grayish-black streak, and all are good conductors of electricity. The latter character may be conveniently shown by the method first pointed out by Von Kobell. A fragment placed in a solution of sulphate of copper (blue vitriol), in contact with a strip of zinc, will become quickly coated with a deposit of metallic copper—a phenomenon not exhibited in the case of common coal. Deducting ash and moisture, true anthracites present, as a mean, the following composition:—Carbon, $92\frac{1}{2}$; hydrogen, $3\frac{1}{2}$; oxygen (with trace of nitrogen), 4. All yield an amount of coke equal to or exceeding 89 per cent. The coke is frequently pulverulent, never agglutinated.

The comportment of anthracite before the blowpipe has not hitherto been given in detail. It is as follows:—*Per se*, the assay quickly loses its metallic brilliancy. After continued ignition, small white specs of ash appear on its edges. In borax it dissolves very slowly, with constant escape of bubbles. It is not attacked by salt of phosphorous; the assay works to the top of the bead, and slowly burns away. In carbonate of soda it effervesces, scintillates, and turns rapidly in the bead; and the soda is gradually absorbed. In the bulb tube a little water is always given off, but without any trace of bituminous matter.

As regards their geological position, the true anthracites belong chiefly to the middle portion of the Palæozoic series, below the carboniferous formation; or otherwise, they constitute the under portion of the coal measures. Frequently, also, anthracites occur in the vicinity of erupted rocks, and amongst metamorphic strata, as manifest alterations of ordinary coal.

2. *Anthracitic Coals.*—These are often confounded with the true anthracites, into which, indeed, as already stated, they gradually merge. Normally, they differ from the true anthracites in being non-conductors of electricity; in burning more easily, and with a very evident yellow flame; in yielding a small quantity of bituminous matter when heated in a tube closed at one end; and in furnishing an amount of coke below 80 per cent. The coke is also in general more or less agglutinated, although it never presents the fused, mamillated appearance of that obtained from caking coal. The mean composition, ash and moisture deducted, may be represented as follows:—Carbon, $89\frac{1}{2}$; hydrogen, 5; oxygen (with trace of nitrogen), $5\frac{1}{2}$: or carbon, 89; hydrogen, 5; oxygen (with trace of nitrogen), 6.

3. *Caking Coals.*—These are often termed, technically, "Fat coals." They constitute the type-series of the coals, properly so called. All yield a fused and mamillated coke, varying in amount from 65 to 70 per cent. Sp. gr. = 1·27-1·32. Commonly mixed with thin layers of strongly soiling "mineral charcoal," or fibrous anthracite. Mean composition, ash and moisture excluded:—Carbon, 87·9; hydrogen, 5·1; oxygen (with nitrogen), 7·0.

4. *Cannel or Gas Coals.*—These coals, at least in normal specimens, do not fuse or "cake" in the fire. They give off a large amount of volatile matter, frequently more than half their weight; hence their popular name of "gas coals." They soil very slightly, or not at all. The coke obtained from them is sometimes fritted, and partially agglutinated, but never fused into globular, mamillated masses, like that obtained from the caking coals. It varies in amount from 30 to 60, or, in typical specimens, from 55 to 58 per cent. Mean composition (normal cannel):—Carbon, 80-85; hydrogen, 5·5; oxygen (with nitrogen) 9-12·5.

5. *Lignites, or Brown Coals.*—These coals, of Tertiary age, differ greatly from one another in external aspect. Some of the so-called jets—passing into the cannel coals—are black, lustrous, and non-soiling; whilst other varieties are brown, and of a ligniform or stratified structure, or otherwise earthy and loosely coherent. All, however, are partially soluble in caustic potash, communicating to it a dark brown colour. The coke—usually of a dull charcoal-like aspect, or in sharp-edged fragments, retaining their original form—varies from 25 to 50 per cent. Its separate fragments are rarely agglutinated, except in the case of certain varieties (as the lignites of Cuba, and those from the fresh-water deposits of the Basse Alpes, in France), which contain asphaltum. All the typical varieties of lignite, as pointed out by Cordier, continue to burn for some time, in the manner of "braise," or ignited wood, after the cessation of the flame occasioned by the combustion of their more volatile constituents; whereas, with ordinary coal, ignition ceases on the flame going out. The mean composition of lignite may be represented by—Carbon, 65-75; hydrogen, 5; oxygen (with nitrogen), 20-30.

All the different kinds of coal enumerated above contain a variable amount of moisture, and of inorganic matter or "ash." The moisture rarely exceeds 3 or 4 per cent., although, in some samples of coal, it is as high as 6 or 7, and even reaches 15 or 20 per cent. in certain lignites. The amount of ash is also necessarily a variable element. In good coals it is under 5—frequently, indeed, under 2 per cent. On the other hand, it sometimes exceeds 8 or 10, and in bad samples even 15 or 20 per cent. The ash may be either argillaceous, argillo-ferruginous, calcareous, or calcareo-ferruginous. The ferruginous ashes are always more or less red or tawny in color, from the presence of sesqui-oxide of iron, derived from the iron pyrites ($Fe S^2$) originally present in the coal. If much pyrites be present, the coal is not available for furnace operations, gas making, engine use, &c., owing to the injurious effects of the disengaged sulphur. Calcareous ashes are more common in Secondary and Tertiary coals than in those of the Palæozoic age. For methods of ascertaining the nature and amount of ash, pyrites, &c., see under § 3 hereafter.

* Hausmann, in his "Handbuch der Mineralogie," gives 2·5 as the extreme hardness of all coals; but this is evidently erroneous, as many specimens, not only of anthracite, but of common and cannel coals, scratch calcareous spar.

§ 2. INSTRUMENTS AND APPLIANCES.

The instruments, &c., employed in these examinations are the following: a blowpipe, blowpipe-lamp, and small spirit-lamp of the ordinary construction; together with the usual accessory instruments and re-agents which always accompany the blowpipe. These require no special description. The blowpipe may be of any form; but for the purpose of heating small platinum vessels in these experiments, it is convenient (although not absolutely necessary) to add to it an extra jet, with an orifice rather larger than usual. The blowpipe-lamp should also be furnished with a broad wick-holder of the pattern recommended by Plattner (Fig. 1), in place of the flat wick-holders formerly in use. In heating crucibles, it is advisable to turn the wick-holder so as to make the upper surface slope towards the right hand, instead of towards the left, the flame being then directed upwards, against and around the bottom of the crucible; or, to avoid the trouble of changing the position of the wick-holder, the operator may turn the lamp itself, placing it with its fore part away from him.

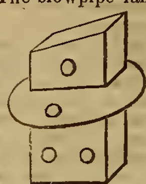


Fig. 1.

In addition to the above, the following appliances, of more special use, are also needed:—(1.) Two platinum capsules, as thin as they can be obtained; one about half an inch in diameter, provided with a small ear or handle, and the other of somewhat smaller dimensions, and without any projecting ear. The smaller capsule, reversed, fits into the larger one, the two then constituting a closed vessel. Those which I employ weigh together less than 42 grains. (2.) A small platinum crucible, with a lid. I make use of two small but deep platinum spoons, one with, and the other without a handle. The latter must be the larger of the two. Its edges must be bent slightly inwards, so as to allow it, when reversed, to be fitted closely over the smaller spoon, and thus to constitute a lid. The long handle of the spoon crucible should be bent, as shown in Fig. 2. The object of this is to enable the crucible to retain an upright position, when placed on the pan of the balance. The figure shows the exact size and form of the crucible employed by me. Its weight is a little under 36 grains. In some spoons a slight notch must be cut in the lid to admit the passing of the handle. (3.) A pair of steel tongs, or forceps, to hold the platinum vessel during ignition. These tongs should be so constructed as to remain closed, except when subjected to the pressure of the fingers. I give a figure of the kind that I employ, because it is much more convenient than the forceps commonly put up in blowpipe cases, or, indeed, than any that I have found described in works on the blowpipe, or in the catalogues of the instrument makers. In using these tongs, the left hand need only be employed. They open by the pressure of the forefinger and thumb upon their sides. (4.) A balance. The most convenient kind of balance for use in these operations is that first contrived by Lingke, of Freiburg, for Plattner's assaying experiments. It is figured and described in detail in the fourth edition of Plattner's "Probirkunst mit dem Löthrohre." This balance takes to pieces, and packs with its weights, forceps, &c., into receptacles cut for it in a small box of pear-tree wood, the size of a thin octavo volume. It can be fitted up, ready for use, in the course of a few minutes, and its delicacy is very great. That which I employ, when loaded with three grammes, a greater weight than it is ever required to carry, turns readily with less than half a milligramme, or the 0.0077th of a grain. It is convenient to have counterpoises for the platinum vessels described above, as the weights belonging to the balance only range from a gramme downwards. A small platinum capsule forms the best kind of counterpoise. It can be trimmed down by a knife or pair of scissors until brought, after repeated trials, to the proper weight. In spare places, in the box containing the balance that I use, I have cut out receptacles for the two platinum vessels and their counterpoises, and I recommend other operators to do the same; because these platinum vessels are of frequent use in various experiments unconnected with the present inquiry, as in ascertaining the amount of water in minerals, and so forth.

Fig. 2.

Fig. 3.

§ 3. OPERATIONS.

In the examination of coals, the following operations are necessary:—(1.) The estimation of the water, or hygrometric moisture, present in the coal. (2.) The estimation and examination of the coke yielded by the coal. (3.) The estimation and examination of the ash, or inorganic matters, present in the coal; and, (4.) The estimation of the sulphur chiefly contained in the coal as $Fe S^2$.

To these might be added the determination of the heating powers of the coal; but this operation—at all times one of more or less uncertainty—cannot be performed by the blowpipe in a satisfactory manner. This, however, is really of little consequence, as apart from the doubtful character of the experiment, even when conducted on the large scale, the relative heating powers of different samples of coal may generally be estimated sufficiently near for practical purposes by a comparison of the amount of coke, ash, and moisture. The litharge test commonly resorted to for the determination of the calorific power of coals, when properly considered, is of very little actual value. Take, for example, the respective results furnished by good wood-charcoal and ordinary coke. These results are closely alike, or rather in favour of the charcoal; and yet experience abundantly proves the stronger heating powers of the coke. It is impossible to raise the temperature of a furnace with charcoal, to anything like the same degree as that obtainable by the employment of coke. Besides which, in practice, it is not, as a general rule, the absolute calorific powers of a coal that constitute its availability for ordinary operations, because a coal—such, for instance, as a brown coal, rich in bitumen—may possess heating powers of considerable amount, but only of short duration; and in cases of this kind, the litharge test becomes again unsatisfactory. Thus, the lignites of the department of the Basse Alpes, already alluded to, yield with litharge from 25 to 26 of lead, whilst many caking coals, practically of much higher heating powers, yield scarcely a greater amount. For these reasons, whilst seeking to discover a satisfactory method of ascertaining directly by the blowpipe the heating power of coals, I leave the subject out of consideration in the present paper.

Estimation of Moisture.—This operation is one of extreme simplicity. Some slight care, however, is required to prevent other volatile matters from being driven off during the expulsion of the hygrometric moisture. Seven or eight small particles, weighing together from 100 to 150 milligrammes, are to be detached from the assay-specimen by means of the cutting pliers, and carefully weighed. They are then to be transferred to a porcelain capsule, with thick bottom, and strongly heated for four or five minutes, on the support sattached to the blowpipe lamp, the unaided flame of the lamp being alone employed for this purpose. It is advisable to place in the capsule, at the same time, a small strip of filtering or white blotting paper, the charring of which will give indications of the temperature becoming too high. The coal, whilst still warm, is then to be transferred to the little brass capsule in which the weighings are performed, and its weight ascertained. In transferring the coal from one vessel to the other, the larger pieces should be removed by a pair of fine brass forceps, and the little particles or dust afterwards swept into the weighing capsule by means of the camel's-hair pencil or small colour-brush belonging to the balance case. The weighing capsule should also be placed in the centre of a half-sheet of glazed writing paper, to prevent the risk of any accidental loss during the transference. After the weighing, the operation must always be repeated, to ensure that no further loss of weight occur. In place of the blowpipe-lamp, the spirit-lamp may be employed for this operation, but with the former there is less danger of the heat becoming too high. By holding a slip of glass for an instant, every now and then, over the capsule, it will soon be seen when the moisture ceases to be given off. It should be remarked that some anthracites decrepitate slightly when thus treated, in which case the porcelain capsule must be covered with a small watch-glass.

Estimation, &c., of Coke.—In this operation the small crucible is employed. Particles are detached from the assay-specimen as before by the cutting-pliers, and about 100 or 150 milligrammes taken for the experiment. The weighing is performed in the crucible itself, this being placed in the little weighing-capsule, with its handle-support projecting over the side. The crucible, with its cover on, is then brought gradually before the blowpipe to a red heat. The escaping gases will take fire, and burn for a few seconds on the outside of the vessel, and a small amount of carbonaceous matter may be deposited upon the cover. This, however, rapidly burns off, on the heat being continued; and as soon as it disappears the crucible is to be withdrawn from the flame, cooled quickly, and weighed always with its cover on. The loss, minus the weight of moisture as ascertained in a previous experiment, gives the amount of volatile or gaseous matter. The residue is the coke and its contained ash. The coke should be examined by a magnifying glass, and its general aspect and characters noted down. As already explained, some coals yield a swollen, semi-fused, and agglutinated coke, with a mamillated surface and metalloidal aspect. Others produce a slightly fritted and partially agglutinated coke; others, again, an unfused coke, retaining the form of the coal fragments subjected to the assay; others, a pulverulent, or a strongly-soiling coke, and so on. It is sometimes desirable to take the specific gravity of the coke.

Estimation of Ash.—The platinum capsule is employed for this operation. The coal must be reduced to a coarse powder, and about 150 millegrammes weighed out for the experiment. The weighing may be effected in the platinum capsule in which the experiment is to be performed. The weight ascertained, the platinum capsule is to be fixed in an inclined position above the spirit-lamp, and heated as strongly as possible. If the wick of the spirit-lamp be pulled up sufficiently, and a very thin capsule, as already directed, be employed, a temperature sufficiently high to burn off the carbon from most coals is in this manner attainable. The lid of the capsule must be placed above the coal-powder until combustion cease, that is to say, until the gaseous products be driven off, and only the uninflammable carbon and ash remain, as, otherwise, a portion of the powder might very easily be lost. Some of the anthracites, also, decrepitate on the first application of the flame; but even if decrepitation rarely ensue when the coal is in the form of powder, it is still advisable in all cases to keep the assay covered until the flame cease. During the after-combustion, the powder or small particles must be gently stirred and carefully turned over, and if agglutinated, broken down by a bright steel spatula, or, better still, by a small spatula of latinum, made by inserting a strip of stout platinum foil (an inch long) into one of the ivory or wooden handles intended to hold platinum spoons. These handles are quite useless for the latter purpose, or, at least, are far inferior to the steel forceps described above. With the forceps, for example, the spoons can be taken up and disengaged in an instant, and without the intervention of the right hand. Whilst the spoons, also, are still red hot, the forceps may be laid down without the spoons coming in contact with the table. Fig. 4 shows the form and size of the spatula that I employ. A is the ivory handle; C the piece of stout platinum foil, fitting into a slit in A; and B the metal ring which keeps the two together. The platinum, it should be remarked, must be sufficiently stout to resist bending; and its point must be kept quite bright and smooth by occasional polishing on a smooth part of the agate mortar which always accompanies the blowpipe. If by the method

Fig. 4.

of procedure just described the carbonaceous matter be not finally burnt off, the flame of the blowpipe—using the oil-lamp or spirit-lamp with the wick well up—may be employed to accelerate the process. The operator, however, must be careful to keep the capsule inclined away from the flame, in order to avoid the loss of any portion of the fine light ash. Finally, when the ash cease to exhibit in any of its parts a black colour, the lid of the capsule is to be cautiously replaced, and the whole cooled and weighed.*

Nature of the Ash.—As already remarked, the ash, or inorganic portion of the coal, may be either argillaceous—consisting, in that case, essentially of a sub-silicate of alumina—or calcareous; and in either case ferruginous also. If free from iron, the ash will be white or pale grey; but if iron be present, it will exhibit a yellowish, brown, or red colour, according to the amount of iron contained in it. The iron is, of course, in the state of sesqui-oxide, derived except perhaps in a few rare instances, entirely from the iron pyrites or bisulphide of iron originally present in the coal. I have found, from numerous trials, that the well-known salt of phosphorus test, so useful in general cases for the detection of siliceous compounds, cannot be safely resorted to for the purpose of distinguishing the nature of the coal ash obtained in these experiments. This is owing to the small quantity of ash, and to the extremely fine state of division in which it is obtained. Argillaceous ashes dissolve in salt of phosphorus with as much facility as those of a calcareous nature, and without producing the characteristic silica-skeleton, or causing the opalization of the glass. With calcareous ashes, also, the amount obtained is never sufficient to saturate even an exceedingly minute bead of borax or salt of phosphorus, and hence no opacity is obtained by the flaming process. The one kind of ash may be distinguished, however, from the other by moistening it, and placing the moistened mass on a piece of reddened litmus paper. Calcareous ashes always contain a certain amount of caustic lime, and thus restore the blue colour of the paper. These calcareous ashes, also, sometimes contain sulphate of lime.† For the detection of the latter, the following well-known test may be resorted to. The ash is to be fused with carbonate of soda and a little borax on charcoal in a reducing flame, and the fused mass thus obtained is to be moistened and placed on a bright silver coin, or on a piece of glazed card; when, if sulphate of lime were present in the ash, a brown or black stain will be produced by the formation of sulphide of silver or of lead. In testing earthy sulphates generally by this process, a little borax should always be added to the carbonate of soda, in order to promote the solution of the assay, and the more ready formation of an alkaline sulphide. If oxide of manganese be present in the ash, by fusion with carbonate of soda and a little borax, we obtain the well-known bluish-green manganate of soda, technically termed a torquoise-enamel.

Estimation of Sulphur.—The method of detecting the presence of sulphur in coal is the same as that just pointed out for the detection of sulphate of lime in the ash. The actual estimation of the sulphur is a much more troublesome operation. A process given by Berthier, in his "Traité des Essais par la voie seche," consists in boiling the ferruginous ash in hydrochloric acid, which dissolves out the sesqui-oxide of iron, and then calculating the sulphur from the loss. One hundred parts, for example, of sesqui-oxide of iron correspond to 70·03 of metallic iron; and hence to 150·24 of iron pyrites, or to 80·21 of sulphur. But this method, besides requiring a larger quantity of ash than can be conveniently prepared in these blowpipe examinations, exacts that the other portion of the ash be not attackable by the acid—a condition which, of course does not obtain in the case of calcareous ashes. For this reason, the process recommended by Rose and other chemists is preferable, although somewhat beyond the range of blowpipe examinations. About 200 milligrammes of the coal in fine powder are to be intimately mixed with eight parts of nitrate of potash, four of carbonate of potash, and sixteen of common salt, and the mixture fused in a platinum crucible over the spirit lamp, with the wick well pulled up, or, better still, over a double current or Berzeliu's lamp. The fused mass is then to be dissolved out in boiling water, to which a few drops of hydrochloric acid have been added, and the sulphuric acid thrown down by chloride of barium. By dividing the precipitate thus obtained (after filtration, careful washing, and ignition) by 7·25, we get the amount of sulphur.

As the above process, although simple enough in the performance, is scarcely available when the operator is away from home, I have attempted to hit upon a more ready method, and one more properly within the legitimate pale of blowpipe experimentation, of ascertaining approximately the amount of sulphur in coal samples. After various trials I have found the following process sufficiently exact for all ordinary cases, because, as a general rule, we merely require to know here, if the coal under examination be slightly, moderately, or highly sulphurous. It consists essentially in comparing the intensity of the stain produced on silver foil by an alkaline sulphide of known composition with that formed by an alkaline sulphide obtained from the assay-coal. For this purpose, mixtures must first be made of a coal free from sulphur, with such proportions of iron pyrites as correspond respectively to a per-centage of two, four, six, eight, and ten parts of sulphur. These proportions are the following:—Coal 96·26, pyrites 3·74 = sulphur 2 per cent. Coal 92·50, pyrites 7·50 = sulphur 4 per cent. Coal 88·76, pyrites 11·24 = sulphur 6 per cent. Coal 85, pyrites 15 = sulphur 8 per cent. Coal 81·27, pyrites 18·73 = 10 per cent. Separate portions of each of these mixtures are to be fused in a platinum spoon, with three parts of a mixture of five parts of carbonate of soda with one part of borax (mixed beforehand, and kept for these experiments in a receptacle of its own); and the fused mass is then to be dissolved out in a measured quantity of water. A single drop of the solution is afterwards to be placed on a piece of silver foil (formed, for example, by beating out a small coin), and suffered to remain upon it for thirty seconds. The silver, wiped dry, is finally to be marked on the back, with the per-centage of sulphur—2, 4, &c.—contained in the prepared coal. When employing this method for the estimation of sulphur, the coal under examination is to be treated in an exactly similar manner, and the stain produced by it on a piece of clean foil compared with the test-stains on the separate silver plates.

Finally, when the iron pyrites in the coal is not in a state of semi-decomposition, the amount of pyrites, and consequently the amount of sulphur, may be arrived at far more nearly than might at first thought be supposed, by the simple process of washing in the agate mortar. Each single part of pyrites, it will be remembered, corresponds to 0·53 of sulphur. A large piece of the assay-coal should be taken, and broken up into powder: and a couple of trials should be made on separate portions of this. About 500 milligrammes may be taken for each trial, and washed in three or four portions. In the hands of one accustomed to the use of the mortar in reducing experiments, the results, owing to the lightness of the coal particles, and the consequent ease with which they are floated off, come out surprisingly near to the truth. In travelling we may dispense with the washing bottle, by employing, in its place, a piece of straight tubing drawn out abruptly to a point. This is to be filled by suction, and the water expelled with the necessary force by blowing down the tube. A tube six inches long and the fourth of an inch in diameter will hold more than a sufficient quantity of water to be used between the separate grindings. The mortar should be very slightly inclined, and the stream of water must not be too strong, otherwise, and especially if the coal be ground up too fine, portions of the iron pyrites may be lost. The proper manipulation, however, is easily acquired by a little practice.

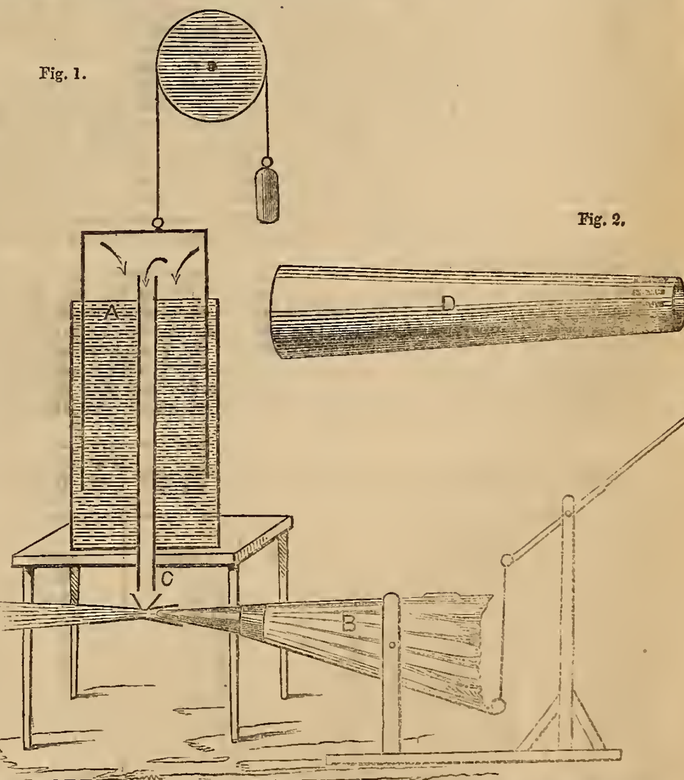
EXPERIMENTS ON THE FORM OF BELLOWS NOZZLES, MADE AT THE SMITHSONIAN INSTITUTE, JUNE, 1855.

By THOMAS EWBANK.*

FROM the earliest times the nozzles of blowing apparatus have been tapered towards the vent, for the purpose of concentrating the blast. Are there circumstances under which a different form may be usefully adopted, and one by which *more* air may be discharged from the nozzle *than issues from the bellows?* These experiments were designed to ascertain whether the apparent impossibility were not a fact.

Fig. 1.

Fig. 2.



The apparatus (Fig. 1) was prepared. A gas-holder, A, having the inverted vessel 13 in. diameter and 28 in. deep, properly balanced. A small forge bel-

---

* If the ash be very ferruginous, the results thus obtained, to be exact, will require correction: the original iron-pyrites of the coal being weighed as sesqui-oxide of iron. In ordinary cases, however—*id est*, in assays as distinguished from analyses—this may be fairly neglected.

When also the ash is calcareous, and in considerable quantity, it should be moistened with a drop of a solution of carbonate of ammonia, and gently re-heated, previous to weighing.

† The ashes of a lignite from Grosspreisen yielded Erdmann:—Carbonate of lime 30·93, sulphate of lime 36·42, lime 17·22, sesqui-oxide of iron 20·67, alumina 1·23, soda 1·86, potash 1·67.

* From the "Journal of the Franklin Institute."

lows, B, worked by a weight on the end of the lever or rockstaff, was so arranged that the nozzles to be tried could be slipped over the ordinary one, and at the same time communicate with the gas-holder through the pipe, C. A scale was attached to the gas-holder by which the rise and fall was measured.

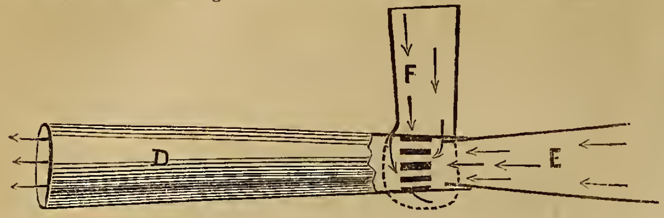


Fig. 3.

Preliminary experiments established the fact that, by reversing the position of the ordinary nozzle, and inserting the smaller end into the bellows, it might be perforated through a part or the whole of its length, and so far from a particle of air rushing through it escaping at the perforations, the external air would be drawn in through them, and augment the volume of the issuing blast.

A series of ten nozzles was at length prepared, their dimensions being limited by those of the experimental bellows. Made of tin plate, they were 3 in. long, and at one end all of the same bore—viz., 5-16ths of an in. The other ends were gradually enlarged from No. 1, which was cylindrical, to No. 10, whose wide end was 17-16ths. D (Fig. 2) represents one of them, having, like the rest, a row of elongated openings round the small end.

A conical tube, E, made to slip tight on the bellows pipe, was fitted and soldered to D, the small end terminating in the rear of the openings as (Fig. 3) in section; the axes of both tubes coinciding, that the blast might not be directed more to one side of D than to another. The end of E enters into D.

A compound tube like this draws in air rapidly at the openings. To ascertain what proportion this air bears to that furnished by the bellows, and proximately to determine the proper angle of the diverging sides of the nozzle, was the object of the gas-holder. Hence, the short pipe F, adapted to enter or receive the end of the pipe, C, of the gas-holder, and made to enclose the openings as indicated by the dotted lines, was soldered and made air-tight at the junction of D and E. This was done with every nozzle.

Turn, now, to the apparatus, Fig. 1, and the process of testing the value of each will be understood. When one (for example, Fig. 3) was connected to the gasometer and bellows, the end of D was closed by the palm of the hand, and the lever of the bellows allowed to descend. The contained air was consequently driven up into the gas-holder, and its ascent marked by the scale gave the quantity received. Then the hand was removed, and the lever permitted to descend as before, when the fall of the gas-holder registered the amount withdrawn by the current passing through the nozzle.

Unnecessary to figure all the nozzles, it is sufficient to give the diameter of the wide ends, since in other points all were alike. The average results of several days' experiments are given below. These were obtained from single strokes of the lever. When the bellows was connected directly to the gas-holder it rose nearly 6 in. It never rose as high when charged through the perforations in the nozzles—through some not over $4\frac{1}{2}$ in. Its passage was checked in the perforations, and the bellows being rather leaky, then leaked the more; hence it would be giving a wrong result—one too favourable to the nozzles—to compare the quantity of air passed through each to the gas-holder with that withdrawn by each.

The quantity of air drawn into the blast, it will be perceived, increased with the divergence of the sides up to No. 7, and then fell to No. 10. The discrepancy presented by No. 6 was doubtless due to defects of construction. The proper angle for the sides of the nozzle would seem, therefore, to be about that of No. 7; still the fact is not sufficiently settled. In another series of tubes were some that gave results approaching those of No. 7, with less divergence. It is a question whether the proper divergence may not vary with the velocity of the blast. The joints of the nozzles with the gas-holder and bellows were made tight with strips of india rubber.

Number of nozzles.	Bore of small end.	Bore of large end.	Fall of gas holder.	Per cent. of gain in the volume of the blast.
No.				
1	$\frac{5}{16}$ of an in.	$\frac{5}{16}$ of an in.	none.	none.
2	$\frac{5}{16}$,,	$\frac{6}{16}$,,	$\frac{1}{2}$ an in.	8+
3	$\frac{5}{16}$,,	$\frac{7}{16}$,,	1 in.	16+
4	$\frac{5}{16}$,,	$\frac{8}{16}$,,	$1\frac{1}{2}$ in.	25
5	$\frac{5}{16}$,,	$\frac{10}{16}$— ,,	$1\frac{3}{4}$ in.	28+
6	$\frac{5}{16}$,,	$\frac{10}{16}$+ ,,	$1\frac{1}{2}$ in.	25—
7	$\frac{5}{16}$,,	$\frac{12}{16}$,,	2 in.	33+
8	$\frac{5}{16}$,,	$\frac{14}{16}$,,	$1\frac{1}{2}$ in.	25
9	$\frac{5}{16}$,,	$\frac{15}{16}$,,	$1\frac{1}{4}$ in.	20—
10	$\frac{5}{16}$,,	$\frac{17}{16}$,,	1 in.	16+

It was of importance to know at what increased outlay of power, if any, this large addition of 30 per cent. and upwards to a blast is to be had. The limited dimensions and imperfections of the apparatus prevented a very accurate reply. From repeated observations, the time of the lever's descent, when the communication of the nozzle with the gas-holder was closed, was five seconds; and when open, five-and-a-half.

Of miscellaneous nozzles, some that were made of machine-perforated plate, same as used in place of wire gauze for meat safes, were tried. The smaller end of one was 7-16ths of an in., the larger 11-16ths, and the length $3\frac{1}{2}$ in. By one descent of the lever it lowered the gas-holder nearly $1\frac{3}{4}$ in.; another, which flared 1-16th more, brought it down to the same point.

The experiments were next varied by arranging the apparatus so as to insert the mouth of the nozzle, D, into the end of pipe, C, and thereby ascertain the effect of *forcing* air into the gas-holder, instead of drawing it out. This would be determined by the difference between the rise of the gas-holder when the tube, F, was left open, and when closed. The perforated plate nozzle last mentioned was first tried. One descent of the lever raised the gas-holder $5\frac{1}{2}$ in. when F was closed, and $7\frac{1}{2}$ when F was open. The other tubes gave much the same result.

It must, however, be observed, that this increased effect ceased when the nozzle, D, was connected to C at *right angles*, either by a tube of india rubber or tin plate. The change of direction and consequent resistance to the current was fatal to an increase of volume.

From this the inference is, that the principle is hardly applicable to forge blasts, or to vents buried in fuel. Be this as it may, there is no question about its application to the domestic bellows, for boards held within an inch of the current issuing from the nozzles had no effect in diminishing the volume. Bellows made on this plan would cost no more than the present one—little more than reversing the position of the nozzle is required. Hand bellows, used by silversmiths, braziers, &c., are more commonly required to diffuse a blast than to concentrate it.

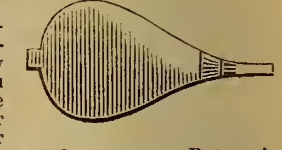
No additional gain was obtained by loading the bellows and making the blast stronger. From various trials, the quantity of air drawn from the gas-holder appeared to depend on that given out by the bellows, irrespective of velocity. It was remarkable how instantaneously the gasometer responded by falling at the least depression of the lever. The slightest breathing through the tube caused it to descend.

The results given are not the highest that were obtained. That 50 per cent., or even more, can be thus added to the blast, I have no doubt. Before the gas-holder was fitted up, a glass receiver was suspended in water as one. By a small nozzle made for the mouth (the smaller end being a $\frac{1}{4}$ in. bore), the receiver was charged by one full expiration from the lungs, and emptied by two-and-a-half directed through the open tube. This was repeated for several days, and was of itself conclusive.

It is a question whether, if the nozzles were flattened, so that instead of a circle, the section might resemble the openings in Fig. 2, the effect might not be further increased.

Irrespective of bellows, this principle of increasing the volume of a blast without enlarging the capacity of the blower is certainly applicable to ventilation, evaporation of liquids, and other purposes in the arts—possibly to some musical wind instruments.

Fig. 4.



As every fact disclosed in physics illustrates, or is illustrated by, natural phenomena, the foregoing experiments may throw light on some atmospheric movements, such as the elevation of masses of air from the earth's surface by lateral gales in the upper regions; and possibly on whirlwinds, for every ascending column necessarily assumes a spiral movement. But passing these, do they not elucidate one of the smallest and commonest of pneumatic processes—that of breathing? How is it that men and animals do not repeatedly inhale the same breath? Laden with poison, air thrown from the lungs seems hardly to have time to get out of the way, so as to avoid being drawn back by the next inspiration. When a person is moving, or standing in a current, there is no difficulty; but during sleep in close rooms, and especially when a sleeper is motionless and respiration rapid, the danger would seem great—still it only appears so. Each respiration excites, as in these blowing tubes, a portion of the surrounding air to accompany it, and instantly to fall in behind, so as to intervene between the mouth and nostrils, and the impure volume ejected. It is as if the expired breath was received into a tube that closed itself when charged, and floated off. But for these aërial envelopes, breathing had been incompatible with health, since more or less expired air would be immediately re-inspired—an evil as injurious as when two persons drink in each other's breath.

ELECTRO-MOTIVE FORCES OF VARIOUS BATTERIES.

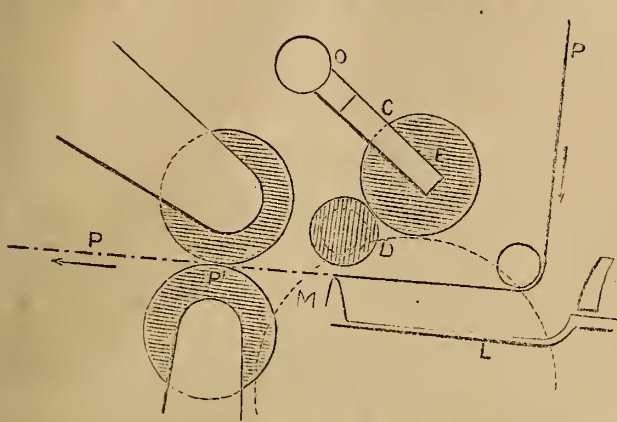
M. Petruscheski, a Russian experimenter, gives the following as the results of his investigations on the power of different voltaic combinations:—

Grove, with amalgamated zinc	1·78
Battery of cast iron and amalgamated zinc	1·72
Bunsen	1·69
Eisenlohr (Daniell's, with tartrate of potassa in place of sulphuric acid)	1·05
Daniell, with chloride of sodium	1·05
,, chloride of sodium and amalgamated zinc	1·01
,, with dilute sulphuric acid	1·00
Eisenlohr, with zinc not amalgamated	0·99
Daniell, dilute sulphuric acid and amalgamated zinc	0.93
Wallaston, with amalgamated zinc	0·93

" Cosmos," vol. xii, p. 4.

A NEW TELEGRAPH.

THE *Cosmos*, for March, describes a modification of the reading apparatus of Morse's telegraph, invented by MM. Digney and Baudouin, which is said to be successful in marking the Morse alphabet in ink upon the paper. The following cut illustrates the arrangement:—D is a thin disk of metal, glass, or other sufficiently-hard material, of from 3-10ths to 4-10ths of an in. in diameter; E, is the inking roller turning freely in its sheaf, which moves around a joint at O, pressing and rubbing gently on the disk D. By means of a screw, the roller may be displaced a short distance parallel to its axis, so as to bring a fresh circumference in contact with the disk. L M is the lever moved by the electro-magnet, similar to those of the common Morse apparatus, but terminating in a



hammer, or kind of knife, whose edge properly rounded raises the paper transversely, and presses it against D, at each vibration of the lever. This band of paper receives its movement from the rollers, P and P', as usual, and is moved in the opposite direction to the motion of the rollers, so that the impression made is well defined. The ink is fat and fluid, dries slowly in the air, and remains a long time viscous.

DIMENSIONS OF NEW STEAMERS.

DIMENSIONS OF THE AMERICAN STEAM-SHIP "LE VOYAGEUR DE LA MER."

Built by George A. Stone, Boston, U.S.; Engines by Atlantic Works, Boston, U.S.

	Ft.	in.
Length on deck	204	0
Breadth of beam	36	8
Depth of hold	15	8
Depth of hold to spar deck	22	0
Length of engine and boiler space	58	6
Hull / Engine-room	1220 tons.	

Kind of engines, oscillating; ditto boilers, vertical tubular; diameter of cylinders, two of 54 in.; length of stroke, 3 ft.; diameter of screw, 15 ft. 6 in., length of screw, 5 ft.; pitch of screw, 28 to 30 ft.; number of blades of screw, four; number of boilers, four; length of ditto, 12 ft. 9 in.; breadth of ditto, 6 ft. 6 in.; height of ditto, exclusive of steam chests, 11 ft. 6 in. Number of furnaces, eight; breadth of ditto, 2 ft. 6 in.; length of fire bars, 8 ft. 6 in.; number of tubes, 2,400; internal diameter of ditto, 2 in.; length of ditto, 5ft.; diameter of chimney, 6 ft. 8 in.; height of ditto, 43 ft. 6 in.; area of immersed section at load draft of 19 ft., 457 sq. ft. Load on safety valve in lbs. per sq. in., 25 to 30, cut off at half stroke; heating surface, 8,000 ft. Date of trial, March, 1858; draft forward, 15 ft.; ditto aft (300 tons of coal), 19 ft.; revolutions (maximum), 40; weight of boilers (without water), 60,000 lbs.

Frames: Shape, L, 6 in. by 3 in., and 18 in. apart; thickness of plates, $\frac{3}{4}$ in. to $\frac{3}{8}$ in.; number of bulkheads, five; diameter of rivets, $\frac{5}{8}$ in. and $\frac{7}{8}$ in.; distances apart, $2\frac{1}{8}$ in.; single rivetted; depth of keel, 18 in.; dimensions of ditto, 10 in. in width; independent steam, fire, and bilge pumps, two; masts, three; rig, ship.

Intended service, Pacha of Egypt.

DIMENSIONS OF THE "HUNTSVILLE" AND "MONTGOMERY."

Hulls built by J. Westervelt and Sons, New York; engines by Morgan Ironworks, New York.

	Ft.	in.	
Length on deck	200	0	
Do. at load line	175	0	
Breadth of beam (molded)	29	0	
Depth of hold	10	4	
Depth of hold to spar deck	18	4	
Area of immersed section at load draft of	13	0	330 sq. ft.
Hull / Engine room	840 tons.		

Description of engine, vertical inverted direct; do. boiler, return tubular; diameter of cylinder, 56 in.; length of stroke, 3 ft. 6 in.; diameter of screw, 14 ft. 3 in.; length of screw, 1 ft. 9 in.; pitch of screw, 21 ft.; number of blades of screw, 4; number of boilers, 1; length of ditto, 15 ft. 2 in.; breadth of ditto, 16 ft.; height of ditto, exclusive of steam chimney, 16 ft.; number of furnaces, 4; breadth of ditto, 3 ft. 4 in.; length of grate bars, 7 ft. 6 in.; number of tubes above, 208; ditto arches below, 4; internal diameter of flues above, $3\frac{1}{4}$ in.; length of ditto above, 12 ft.; ditto arches below, 4 ft. 6 in.; diameter of smoke-pipe, 5 ft. 2 in.; height of ditto, 22 ft.; draft forward, 13 ft.; ditto aft, 13 ft. Date of trial, April, 1858; maximum pressure of steam, 25 lbs.

Frames: molded, 14 in.; sided, 12 in.; 24 in. apart from centres, and strapped with diagonal and double-laid braces, $4\frac{1}{2}$ in. by 5-8th in.; depth of keel, 12 in.; independent steam, fire, and bilge pumps, 1; masts, 3; rig, square forward.

Intended service, New York to Savannah.

PROPELLERS FOR CUBA.

MESSRS. Merrick and Sons, of Philadelphia, U.S., have recently finished for Don Pedro Lacoste, of Havana, two steamers built expressly to carry freight and passengers between Cardenas and Havana. Their names are *Cardenas* and *Alfonso*, and their principal dimensions are as follows, viz.:—

Length on deck	180 feet.
Beam	30 ,,
Hold	11 ,,

Schooner rigged, with three masts.

Each vessel has two vertical cross-head condensing engines placed across the vessel, and driving the propeller shaft by gearing $2\frac{3}{4}$ to 1. Diameter of cylinders, 40 in.; stroke, 3 ft.; average revolutions of engines, 32; diameter of propeller, 8 ft. 6 in.; length on shaft, 2 ft.; 4 blades. Average pressure of steam, 25 in.; throttle open and cutting off at 13 in. from commencement of stroke; vacuum, 26 in. Taking the distance from the Navy Yard Shears to Fort Mifflin as $8\frac{1}{4}$ miles, *which it is usually called on trial trips*, their average speed with and against the tide, light, was 13·43 miles per hour—and loaded with 340 tons of coal on board, 13 miles per hour; but as the real distance is but 7·13, instead of $8\frac{1}{4}$ miles, so the real speed, light, was 11·60 miles, and loaded 11·24 miles. The hulls of these vessels were modelled and built by the Messrs. Cramp, of Kensington, and for beauty of form and excellence of workmanship would be difficult to surpass.

THE FIRST LOCOMOTIVES IN THE UNITED STATES.

THESE engines (says the "Journal of the Franklin Institute") were brought over from England by Horatio Allen, of New York, in the fall of 1829 or the spring of 1830; and one of them was set up on the Delaware and Hudson Railroad, at Carbondale, Pennsylvania, but being found too heavy for the track, its use was abandoned. The first locomotive constructed in this country was built by the West Point Foundry, at New York, in 1830, for the South Carolina Railroad, and named the "Phœnix"—a second engine was built the same year by the same establishment, and for the same road, and named the "West Point." In the spring of 1831, a third engine was built by the same establishment for the Mohawk and Hudson Railroad, from Albany to Schenectady, and called the "De Witt Clinton;" this was the first locomotive run in the State of New York. This engine was put on the road by David Matthew, who now resides in this city, and has been connected with railroads since that time. The first Stephenson locomotive ever imported into this country was the "Robert Fulton;" this engine was brought out in the summer of 1831 for the Mohawk and Hudson Railroad, subsequently rebuilt and named the "John Bull."

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we purpose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar and intelligible shape.—ED.

A WORKMAN *v.* HIS FOREMAN.—A novel action for damages arising from an accident has recently been tried in the Common Pleas. The plaintiff was a moulder's assistant, in the employ of Messrs. Hood, extensive metal-moulders at Woolwich. The defendant is foreman in the same employ. The accident arose in moulding a gas-retort, 4 ft. in diameter, moulding-pit 9 ft. deep and 8 ft. wide. Into the mould, on the day before the accident, had been poured two or three tons of liquid metal, which would take about three days to cool; the next day, however, the plaintiff had been ordered by the defendant to go down into the pit to fix the chain to raise the mould. He had scarcely done so, when defendant gave orders to raise the mould: the act of raising caused the hot sand in the mould to flow out on the plaintiff and his helpmate, who was removed to the *Dreadnought* hospital-ship so dreadfully burnt that he died, and plaintiff himself had to remain in the hospital for six weeks amidst dreadful sufferings. The negligence alleged was the defendant ordering the mould to be raised before the men were out of the pit. Two grounds of defence were pleaded—one technical, and the other to the merits. The legal objection was that *as between one servant and another* an action would not lie. The defence on the merits was, that an order had been given to leave the pit, but no order to hoist the mould; and, further, it was suggested that there might have been some air in the mould, which caused the sand to run from it. As to the legal objection, the Court (sittings in Middlesex, before Mr. Justice Crowder and a Common Jury) said that the action was, undoubtedly, a novel one—one workman against another for an accident arising in the same employ; but they would not stop the case, leave being reserved to move the court upon the matter. Verdict for plaintiff, with £20 damages.

COPYRIGHT IN DESIGNS.—Vice-Chancellor Sir W. P. Wood has recently (July 12) decided that, in order to obtain the protection given by the Copyright in Designs Acts, 5th and 6th Victoria, cap. 100, it is not necessary that the design deposited with the Registrar should be on paper, or any particular kind of paper; but that the deposit of an actual

manufactured specimen of the article itself was not only sufficient for the purposes of the Act, but even in some possible instances the preferable mode of proceeding. His remarks on that occasion are so important to future applicants for protection under the Registry Acts, that we subjoin them nearly in full :—

"The defence here is that the plaintiff has not deposited with the Registrar any *drawing on paper* showing the particular portions in respect of which originality is claimed. I see nothing in the Acts upon the subject laying down that the design must be on paper. Many instances might be suggested in which the design could not be better shown than on the material to which it is intended to be applied. Is it less a copy of a design because it is copied on to the very material to which it is proposed to be applied? The defendant has also contended that, although the design may be contained in the shawl deposited, yet there is nothing to show him which is the part for which protection is claimed. *No specification, however, is required under the Act.* It is enough to file the design, the defendant being bound to see if there is anything new in it, and to avoid any infringement of such portion. So long as any part is new, the design is not vitiated by the circumstance that much that is old, and for which protection cannot be claimed, is retained. So far from the public being misled, they will be benefitted by having the design *exhibited in its applied form*, and not merely as a tracing upon paper. The defendant's objection has, therefore, failed.

The case in question (Norton *v.* Nicholls) was an application for an injunction to restrain the sale of what is known in the trade as the "Mantilla Shawl," with the plaintiff's registered design applied thereto, or of any shawl so as to infringe upon such registered design. The defence was, that the plaintiff had not properly registered his design; that he had deposited with the Registrar of Designs, under the Copyright in Designs Act, 5th and 6th Victoria, cap. 100, one of his shawls containing the improvements in point of design and shape for which he claimed protection as being new and original, but that he had not deposited with the Registrar any drawing or design on paper, &c.

Non-Liability of Railway Companies for Certain Accidents.—As a set-off against the past month's unprecedentedly long list of railway actions for injury sustained, and heavy damages awarded, we direct attention to one remarkable case in which railway companies have been judicially declared not to be answerable. In the Court of Exchequer (28th June ult.), an action for damages sustained from a railway accident was brought by the plaintiff (Bird) against the Great Northern Railway Company. The accident occurred 24th September last near Tuxton, when the train, in which the plaintiff was a passenger, fell over an embankment 35 ft. high. Five persons were killed, and plaintiff and several others severely injured. It was *suggested* that the accident arose from some defective *joints in the rails.* No positive or direct evidence of this, however, was forthcoming, nor does the plaintiff appear to have been in a position otherwise to prove the actual and immediate cause of the accident; an inability (likely enough, we imagine, to exist in most of these cases) which the Lord Chief Baron seems to have considered as fatal to his claim for compensation, since he told the jury—"No doubt the plaintiff must show that something which could *have been guarded against* had occurred—for railway companies did not *insure the lives of passengers.*" The special jury accordingly found a verdict for the defendants, stating that "they were not satisfied that there was evidence of negligence."

Impediments to Navigation by Piles and Launching-Ways.—In a recent action for damages, brought in the Court of Queen's Bench by the Blackwall Railway Company against the Thames Iron Works and Shipbuilding Company, a verdict was returned which will probably have the effect of rendering both companies and individuals more cautious for the future in dealing for their private requirements with the great lines of public transit, whether by water or land. The compensation claimed was for the loss of a barge from the wharf of the Blackwall Railway, sunk in consequence of fouling on some piles and launching-ways in the bed of Bow-creek, at the mouth of the river Lea. An iron bolt projected about 3 in. from one of the timbers of the launching-ways: the barge, carried by the tide, struck against this bolt; the side was perforated by the concussion, and the barge, rapidly filling, went down with the whole of its contents—the bargeman narrowly escaping. The defence imputed negligence to the bargeman. Lord Campbell left it to the jury to say "whether the accident occurred by the defendant's negligence by placing their launching-ways out in the river, so as to obstruct the navigation." The jury returned a verdict in the affirmative, with £500 damages.

Tempering Steel Wire, &c.—In an action for infringement of patent right recently (July 9) tried in the Court of Common Pleas, Guildhall, before Lord Chief Justice Cockburn, some interesting details as to the method of tempering steel for pianoforte-wire and other purposes were given in evidence.

Both plaintiffs and defendants were manufacturers of wire for pianofortes and other musical instruments, near Birmingham, and the question turned on the alleged infringement by the defendants, Smith and another, of a patent of which the plaintiffs, Webster and another, were the assignees; the specification directing that "after the wire has been drawn by the usual process to nearly the diameter which it is intended the finished wire shall have, the wire is to be heated to redness, and when so heated immersed in water or oil. By this treatment the wire is made hard. The hardened wire is to be then plunged into a bath of melted lead, or other bath, having about the temperature of the melting point of lead. The wire is to remain in the bath until it has acquired the desired temper, the length of time varying with the size of the wire." The invention claimed was the hardening and tempering steel-wire for pianofortes and other musical instruments, previous to the final drawing by which the wire is reduced to the proper diameter.

The defendants, or one of them, had themselves taken out a patent for improvements in the manufacture of steel-wire, &c., and their case was that they had manufactured the wire sold by them by the means specified in that patent, and not by the mode specified in the plaintiffs'.

As regarded the question of novelty in the invention, the evidence was given of persons who had for years pursued an analogous process to the plaintiffs' in the hardening and tempering of steel for the manufacture of watch-springs in the way of their trade, and sold the product publicly. In a few instances, the steel wire produced by one of these witnesses was sold for musical instruments.

The Lord Chief Justice told the jury that if they believed the evidence of these witnesses, he should direct them to find a verdict for the defendant, on the ground of want of novelty. As to the question of infringement, he left it to the jury to say whether the defendants worked under their own patent; and if so, whether they hardened and tempered the steel-wire before final drawing, in the sense specified in the plaintiffs' patent.—Verdict for defendants.

Responsibility for Telegrams.—In the Queen's Bench, July 6, an action (Whitfield and another *v.* The South Eastern Railway Company) was brought for compensation in damages for injuries sustained by the plaintiffs (a banking firm at Lewes), in consequence of the defendants having sent by the telegraph on their railway a message to the various branches, to the effect that the Lewes Bank had stopped payment, at the same time transmitting to every station on their line an order not to take any of the Lewes notes in payment. In evidence it appeared that on the 9th July, 1857, the injurious communication reached the head quarters of the company in London. They adopted it without the slightest inquiry as to its truth, and transmitted it to all their stations. The message was even posted up in some of the offices, by the side of another announcement of the Hastings Bank having stopped payment. The message reached Lewes about twelve or one in the day. A run upon the bank immediately began, but, fortunately, it did not get to the branches until after closing time, or otherwise the panic the news had created amongst the holders of notes, &c., might have proved fatal. The London agents of the Lewes Bank did, indeed, obtain a contradiction; but the company refused to give up the name of their informant. Evidence of publication, and also that the practice of all other companies was to bind their servants to strict secrecy as to all messages passing through their hands, was given. The company's defence was, that the message in question was a privileged communication from their cashier to the stations. The jury, however, returned a verdict for the plaintiffs, with £2,000 damages.

Full Costs in Patent Cases.—In the Vice-Chancellor's Court, July 2 (Lister *v.* Leather), on granting a perpetual injunction to restrain infringement of plaintiff's patent rights and sale by defendant of "Crabtree Machines," the Court (under the provisions of the 43rd section of the Patent Law Amendment Act) made an order for the defendant to pay to plaintiff his "*costs as between solicitor and client*;" in other words, his full costs, including many legal charges, as for consultations, extra advice, &c., which formerly, as not being "costs as between *party and party*," he would not have been enabled to claim from a defendant, but would have had to pay to his legal advisers out of his own pocket.

Danger to Public Roads from Undermining.—At the Wolverhampton Petty Sessions, on the 7th July ult., an ironmaster and proprietor of coal pits at Moseley Hole, near Wolverhampton, was summoned by the Trustees of the Wolverhampton Turnpike Roads for refusing to allow a surveyor of the trustees to examine his pits, the working of which was *undermining the said roads*, thereby endangering the lives of the public. The Act of Parliament empowering the trustees to appoint a person to descend any pit whenever danger to the roads was observable from their working was produced. Evidence was also given of the due appointment of the surveyor, and of the refusal by the pitowner to allow him to descend the pits and inspect them. The magistrate (Mr. Kettle) said there must be a conviction. The pitowner would be fined £10, to be reduced to 1s. and costs if the surveyor were allowed to descend the pits and make his report upon the damage done, compensation for which the trustees could recover in another way.

Damages for Railway Accidents.—The past month has been more than usually prolific in legal claims for compensation for injuries sustained; nor is the willingness of juries to give ample, not to say in some instances, exemplary damages, less remarkable. If severity of censure in this form can prove of any avail in enforcing the dictates of humanity in antagonism with self-seeking and greed, we may hope, for the future, to find some greater attention bestowed on the amelioration of—we regret to say—the almost generally defective system of railway management, obnoxious alike to the animadversions of judges, juries, and parliamentary enquirers. A concise enumeration of the actions for damages to which we allude, will form the best commentary to our remark :—

Great Northern.—In the Common Pleas (Nisi Prius' sitting of the 7th July, Smith and Another *v.* the Great Northern Railway), the action was brought by the Executors of the late Mr. George Cox, on behalf of his widow and six children. On the 20th August last the deceased was alighting from the train, which stopped at Colney Hatch, but when his foot was on the step, the train was suddenly pushed back, and the concussion threw him down; he fell under the wheels, and his head was severed from his body! The defence set up by the Company was, that there was no negligence on the part of the Company's servants. It was admitted that there was only one porter in attendance at the station at night; but, it was added, "the Colney Hatch station was an unimportant one." The driver, having overshot the station, blew his danger-signal, and instantly reversed the engine, so that the train began its backward motion immediately it came to a stand-still. It was likewise admitted that under such circumstances the hinder part of the train would lie at rest for a short time. The Jury gave a verdict for plaintiffs, with £1,000 damages, and left it to the Judge to say how it should be divided amongst the widow and children.

North Western.—In the Common Pleas (2nd Court, July 7th).—The plaintiff (Mr. Kerby) was a solicitor in good practice. On the 22nd March last he left Rugby by the Express train. Just beyond Watford station some plate-layers were employed repairing the line. No signal was given as the train approached: it ran on at the rate of from forty to fifty miles an hour. The carriages fell over upon the line, and plaintiff was helped out of the window, seriously (and, possibly, permanently) injured in health and professional aptitude. The Company admitted their liability, and the Jury found a verdict for the plaintiff. Damages, £1,000.

Shropshire Union.—In this case, tried in the Court of Queen's Bench (7th July) before Lord Campbell and a special jury, the plaintiff, Mr. Wynne, a Government inspector of mines, was on the 6th July, 1857, a first-class passenger from Stafford to Shrewsbury. At the Gnoshall station, the train, going at a speed of between 40 and 50 miles an hour, on a steep descent, the carriages oscillated with great violence, two trucks (part of the train) were thrown off the line, the engine and tender being detached went ahead, and owing to the trucks being unprovided with spring-buffers, the carriages struck against each other with a great shock, several passengers were more or less injured, and plaintiff received a violent blow on the spine, which deprived him of the use of his lower limbs, and incapacitated him from pursuing his profession; his salary, as inspector of mines, being £600 a year. At the suggestion of Lord Campbell, a verdict was taken by consent for plaintiff, the question of damages being referred to Mr. Serjeant Shee.

South Eastern.—In this case (tried at Nisi Prius sitting at Guildhall, before Mr. Justice Hill, and a special jury), the plaintiff, Mrs. Search, claimed compensation for injuries sustained in the collision at Lewisham on the 28th June, 1857. The company had paid £1,000 into Court, and disputed their further liability, alleging that Mrs. Search, who was a milliner, had over-rated her loss, &c. For the plaintiff it was alleged, that previously to the accident she was making about £900 a year, and the jury were asked to give her three years' purchase, or £2,700; and several hundreds more for medical and other expenses, bodily suffering, &c., she being, as it was alleged, totally incapacitated from carrying on her business. The plaintiff did not appear in person. The Judge commented on this, as likewise on the absence of witnesses as to domestic and business losses. Verdict for plaintiff, £1,500 damages, or £500 beyond the amount paid into court.

Eastern Counties.—In the Secondaries' Court (9th July ult.) a jury assessed damages for the breaking down of a railway carriage at Retford. The damages were laid by the plaintiff (Mr. Smith) at £5,000. A verdict was taken, by consent, for £800.

London and North Western.—Oxford Circuit, Civil Court, before Mr. Justice Byles and a special jury.—The Plaintiff, a Russian agent, of London, was, on the 22nd March last, a second-class passenger on this line. After passing Watford, at from 45 to 50 miles an hour, they came upon a part of the road on which some workmen were laying down rails, but had not sufficient time to fasten them properly to the chairs before the express train came up; the train was, in consequence, thrown off the line, plaintiff and others sustaining (alleged) irreparable injury. The defence relied upon in this case was, great exaggeration of injury as sustained by the plaintiff, who was severely cross-examined on that point. The jury, however, gave a verdict in his favour for £700, adding that the Company ought to pay all costs. Mr. Justice Byles said, "the law will take care of that."

Railway Luggage.—The Court of Common Pleas have recently decided that railway travellers are not bound to take care of any portion of their luggage. A passenger may hand all his luggage to the Company's servants, who are legally responsible for its safety.

Railway Travellers.—At the Berwick County Court a case of some importance to travellers by railway has been recently decided. A Mr. Gray sued the North-Eastern Railway Company for £3 3s., loss sustained by him from being detained on his journey south by delay of defendants' conveyance. One day in April last plaintiff proceeded from Cornhill station, by defendants' train, to Tweedmouth, to join express train south. Through some mismanagement he arrived too late. The defence was, that the Company did not guarantee to join any particular train *on another line*; further, they alleged the occurrence of an accident on the British line. The Judge did not think such accident a sufficient excuse, and gave judgment for the plaintiff.

PHOTOGRAPHY AND THE BUILDING ACT.—A question of some importance in its particular sphere of operation was, on the 11th June ult., disposed of by Mr. Combe at the Southwark Police Court. A photographic artist was summoned by the district surveyor for having a building constructed contrary to the Act of Parliament: that is, the walls not being built of brick or other incombustible material. It appeared that, for the purpose of his business, as a photographic artist, the defendant had erected in his front garden a glass outhouse, or shed, 14 ft. by 9 ft., and 10 ft. high. No fire was ever kept in this place, and there was nothing carried on that endangered the adjacent building; but the surveyor considered it a building within the meaning of the Act, and required the magistrate to make an order to have it pulled down and rebuilt with bricks, or other incombustible materials; a direction which would have had the effect of preventing the defendant from carring on his business as a photographist. The magistrate, who had proceeded to view the premises, declared, on his return, that he was surprised at the surveyor having summoned the defendant under the Metropolitan Building Act. The place he had seen could not be called by any reasonable man a building within the meaning of that Act. He might as well call a sentry-box, or a dog-kennel, a "building." The place was composed of glass and wood. It was moveable, and not fixed in the ground, and there was no business earried on inside that placed the adjacent premises in jeopardy from fire. Under these circumstances, he should dismiss the summons. The defendant applied for costs; but the magistrate refused them, as the case turned more on a point of law, which it was of some importance to settle.

IN another recent PHOTOGRAPHIC case, Law was less indulgent to Art. At Worship Street Police Court the proprietor of a photographic "establishment" in Whitechapel summoned a gentleman who was stated to have "smashed," or "carried off"—it did not clearly appear which—a lady's likeness exhibited outside the "establishment." It turned out to be the portrait of the gentleman's wife—a fact not originally stated, but elicited in answer to questions put by the magistrate. The magistrate to the complainant: "What right had you with the likeness? Very possibly, had I been passing, and perceived the portrait of my wife exposed, I should have done the same thing. I shall refuse the summons."

NEGLIGENCE OF A DRUGGIST.—Richards v. Cocking, Queen's Bench, 6th July ult.—This was an action for injuries sustained in consequence of the defendant, a chemist in Great Portland-street, giving the plaintiff, by mistake, a dose of Sir William Burnett's disinfecting fluid (chloride of zinc), instead of "fluid magnesia," as asked for by the plaintiff (sulphate of magnesia or tasteless Epsom salts), "whereby the plaintiff was nearly poisoned." The Jury found a verdict for plaintiff, with £75 damages.

THE NEW SMOKE-CONSUMING ACT comes into operation on the 1st of the present month (August). Its enactments, which are somewhat severe, equally affect furnaces on land and steamboats on the river. The fines imposed are to double in amount on every new conviction.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

WE have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

BREWERIES.—Between October, 1856, and October, 1857, there were in the United Kingdom 2,416 brewers; in the year preceding, 2,453; showing a slight decrease (of 37) in the year 1857.

ARTS, MANUFACTURES, AND COMMERCE.—The 104th Anniversary of the Society of Arts, &c., was held (June 24th ult.) at St. James's Hall, Piccadilly, the Earl of Carlisle presiding.

THE BOARD OF TRADE RETURNS for the past month (issued 24th June) again show a heavy falling off in our exportations, the heaviest reduction being in woollen goods and metals, especially iron. The difference of all exports, as compared with corresponding month of last year, was £1,117,556.

AN EXPLOSION has taken place at BRENTFORD DISTILLERY, by which one person was killed whilst cleaning out the vats. The confined air, coming in contact with a lighted candle, exploded like a park of artillery, carrying away part of the roof and burning the unfortunate man to death.

WOOD EMBOSSING, for Bookbinding, Enriched Panelling, and various other Decorative and Ornamental Purposes.—A newly-invented process, for so softening wood that it may be pressed into iron moulds, and receive sharp and permanent impressions in bas-relief, has, under the name of "XYLOPLASTY," attracted much notice at Paris. The wood is softened by steam, and imbued with certain ingredients that impart to it sufficient ductility to enable it to receive bas-relief impressions from four to five millemetres in height. For medallions, bosses, &c., mastic is forced into the hollows, so that all tendency in the compressed wood to open or split is completely overcome. For bookbinding purposes much seems to be anticipated from this process, as it is applicable to the scented or odoriferous woods—cedar, cypress, teak, rosewood, &c., which are *vermifuge* in their nature, so that, through their covers, books will in future be protected from the ravages of insects.

METALLIC CARDBOARD FOR ROOFS, &C.—A new invention, by M. de Ruolz, under the title of "Non-bituminous Cardboard," has been introduced as a substitute for zinc, tiles, or slates, in the roofing chiefly of barns, granaries, outhouses, &c. In its construction the use of bituminous matters, such as pitch and tar, as being subject to waste and other inconvenience from the action of the sun, the heat of chimneys, and other causes, is altogether discarded. The material employed is a strong fibrous kind of cardboard, manufactured expressly for the purpose from old ropes, and covered with a metallic cement, alleged to be waterproof, and to a great extent also fire-proof. Its use appears to have been already pretty extensively adopted in France for railway-stations, and buildings, both public and private, wherein protection from damp is an essential requisite.

FRIGHTFUL ACCIDENT FROM MACHINERY.—At the Saw Mills in Hunslet-lane, Leeds, belonging to Mr. Pratt, timber merchant, a workman was (on the 26th June ult.) literally torn to pieces. He was endeavouring to replace a strap on the drum, while the latter was in motion; his arm got entangled, and he was whirled round the shaft.

THE HORSE-NAIL MAKERS of Rotherham and Thorpe are still on strike against a reduction of 5 per cent. and upwards, since the 3rd of May last.

AT DANTZIC (Prussia) several great factories, flour mills, and warehouses, have been destroyed by fire.

ART MANUFACTURES. — The new exhibition of modern art-manufactures, either designed or executed by students of the Government School of Art, has been opened to the public at the Science and Art Department of the South Kensington Museum: this being the first attempt made to illustrate the practical influence of the Schools of Art.

LONDON SEWAGE.—The Metropolitan Board of Works have adopted so much of the report of Messrs. Bidder, Hawksley, and Bazalgette, as relates to the high and middle level sewers on the north side of the Thames, and to the high and low level sewers on the south side — the deodorizing of the western sewage at its junction with the Thames—the low level sewer upon the north side to be carried in a Thames embankment between Westminster and London bridges. The Board to pay a just drainage proportion of the expense of such embankment.

PROVINCIAL SCHOOLS OF ART.—From the 5th report of the Government Science and Art Department it appears that during the year 1856-7, 8,516 students attended in thirty-nine provincial schools of art, including 104 architects, 45 builders, 257 carpenters, 73 carvers, 82 cabinet makers, 88 draughtsmen, 120 designers, 54 die-sinkers, 180 engravers, 213 engineers, 68 jewellers, 541 mechanics, 163 metal-workers, and 44 modellers.

LONDON MECHANICS' INSTITUTION.—In reply to the somewhat unfavourable report of Dr. Lyon Playfair, ordered by the House of Commons to be printed (26th March last), the Committee have just published a statement, the chief points of which are—the low state of the funds of the institution; the "consequent injurious economy, which has been the great cause of its decline, by actually precluding its legitimate objects being carried out;" and the "competition arising from evening classes at colleges and governmental institutions for conveying high-class instruction at a low cost." The explanatory address concludes with an appeal "to all friends of education and kindred societies to assist the exertions of the Committee to secure the help of the Government, to prevent *the parent institution of England* from closing."

PRESERVATION OF STONE, &C.—The Government have commissioned Mr. Szerelmy, the inventor and patentee of a composition for preserving stone and iron from injury by atmospheric agency, to apply his material to such portions of the walls of the new Houses of Parliament as may require it.

THE EXPENDITURE OF THE METROPOLITAN BOARD OF WORKS, it appears, from a recent Parliamentary Paper, has been, from January 1st, 1856, to July 1st, 1857—Sewerage, £112,593; contingencies, £7,199; establishment charges, £35,659.

THE AMERICAN FLINT GLASS COMPANY'S FACTORY at Hunter's Point, in the vicinity of New York, was blown down on the 21st June ult. by a furious tornado.

DECORATIVE ART.—A series of effigies or portraits of the Tudor family is now executing for the "Prince's Chamber" in the new Palace of Westminster, in the training school of the Department of Arts, by Mr. Burchett, the head master, and some of the students. The series is to contain, when complete, twenty-eight portraits; the backgrounds in gold, enriched by ornaments incised, or impressed ornament, whilst the composition is soft—a method of ornamentation that has not been used in this country at least for the last three centuries.

THAMES PURIFICATION.—In the House of Commons (July 8) a motion, that the cost of purifying the Thames in the vicinity of the metropolis should be borne by the Consolidated Fund and the metropolitan ratepayers, in equal proportions, was negatived without a division.

PROVINCIAL SCHOOLS OF ART. — The attention of the Government having been called to the alleged injudicious diminution, in some instances, of the allowance to encourage provincial schools of art, before reasonable time had been allowed for them to become self-supporting, an official assurance was given (in the House of Commons, July 8,) that no such partiality as was complained of would be shown, as between London and the provinces.

MECHANICAL MOUTH FOR POSTAGE STAMPS.—A contrivance for damping both sides of the adhesive stamp, to avoid the application of the mouth, has been recently introduced. It presents the appearance of a glass inkstand, and imitates the action of the lips, the tongue, and the salivary glands.

THE WATT PREMIUM MEDAL.—The Council of the Institution of Civil Engineers have lately adopted two new kinds of premium for communications thought worthy of honorary reward. One of them—namely, the "Watt Medal"—is to be reserved for excellence in mechanical subjects. The medal has been engraved by Mr. J. S. Wyon. On the obverse is a beautifully executed medallion likeness of James Watt, and on the reverse is a representation of the steam-engine as constructed by him.

LONDON DRAINAGE.—In the City of London alone there are 45½ miles of sewers, large enough for men to enter. For these sewers there are 2,810 gullies of every description, and 1,065 air-shafts, with ventilators, making 3,875 openings to the sewers from public ways. The total length of horizontal drain is 54,718 ft. Total number of inlets of all descriptions, 2,696. Taking 16,300 as the number of houses within the City, the length of the house-drains is about 891,903 ft., or 168 miles. Within the City of London there are 48 miles of sewer and 168 miles of house-drain, and the number of air-shafts, gulleys, and inlets, is 47,819.

SANITARY FURNACES.—Amongst other remedial and preventive measures, Mr. Goldsworthy Gurney proposes to burn the noxious gases arising from the London sewerage. The cost of furnaces, &c., under this method, if ultimately adopted, as there is some reason to suppose it will be, by the Metropolitan Board of Health, will be something like £100.000 a-year (according to other estimates, from £50,000 to £60,000). After all, this expedient, which has for some time past been successfully applied to the ventilation of mines, would not relieve the river, but merely the streets, from stench and poisonous exhalations.

PIRACY OF TRADE MARKS.—In the House of Commons (9th July), Mr. Roebuck asked the Under Secretary for Foreign Affairs whether the Government were prepared to afford redress to the Sheffield and Birmingham manufacturers, who complained of their names being fraudulently placed upon foreign articles of manufacture. He received a reply to the effect that Government hoped, before the end of the Session, to introduce a measure, based on a convention with foreign countries, to remedy the grievance complained of.

ART INSTITUTIONS. — The vote, in supply (£73,730), for Government Schools of Science and Art, was agreed to on the 9th July ult., after an ineffectual proposal to reduce it by £9,045, increase on the vote of last year.

THE (PROPOSED) NEW METROPOLITAN BOARD OF WORKS.—The Chancellor of the Exchequer, in introducing the Drainage, &c., Bill (15th July) stated, "What we have sought to do is to make the Metropolitan Board of Works a real Corporation—to invest it with sufficient funds—to endow it with sufficient power; and to give it not only power, but responsibility—a responsibility which cannot be expected unless we leave it perfectly unshackled and untrammelled."

"ENRICHED" CEILINGS.—In the House of Lords on the evening of the 16th July ult., and during the debate, a portion of the ornamental work of the ceiling fell with considerable noise between two noble Lords, who had a narrow escape, the falling mass actually grazing the head of one of them (the Earl of Shelburne). The fragment which gave way was a portion of that part of the roof which was inscribed with the words "*Dieu et mon Droit*," in Gothic characters.

PARISIAN SYSTEM OF SEWERS.—The "Constitutionnel" recommends to the English Board of Health the improved system of late adopted by the Prefecture of the Seine. The sewers are placed, by *subterranean galleries*, in communication with the houses, and the refuse of all kinds is carried away by waggons running on rails. Thus, the underground galleries, which form the fœcal organs of the great city, are like those of the human body, without being visible and without entailing any disagreeable effects.

A London and North Sea Fishing Company has been started; capital, £100,000. Principal establishment to be at King's Lynn, Norfolk. Operations to commence with a fleet of thirty-two fishing smacks, well-manned and completely equipped. The prospectus affords a fair prospect of commercial success; at all events, the scheme is highly illustrative of the new school of commercial energy and enterprise.

Silkworms in Australia.—According to some recent observations, there is some reasonable prospect of our silk-looms being (in part at least) supplied with the raw material from our Australian colonies. Mr. Gerard Krefft, who took charge of a collecting party lately fitted out by the Victorian Government, has furnished some interesting particulars on this subject. The cocoons are generally found deposited under the loose bark of the *Eucalyptus rostrata*, Echl., or *Eucalyptus acuminata*, Hook, the "flooded gum-tree" of the colonists; and are the productions of a large hairy caterpillar, from 2 to 3 in. in length, which feeds on various shrubs, and eventually selects the bark of the flooded gum-tree for its transformation into the cocoon. Specimens of the *moth* are at the Melbourne Museum. This caterpillar, or silkworm, is distributed over a great tract of country, and is found along the banks of the Murray from Maiden's Point to the Darling Junction, and about 100 miles along the bank of the river.

"Blast-Drill," *for the Turnip fly*.—In the list of patents for which provisional protection has been taken is one for a machine described under this title, the object of which is to protect the turnip-crop from the ravages of the fly and the slug. The common practice is by dusting the row with lime during the night and while the dew is upon the plant, an operation at once difficult, and always imperfectly performed—the difficulty being of dusting the under side of the plant as well as the top side. In the new plan, the lime, mixed with one-sixth of soot, is thrown, by means of a blast-fan, upon every part of the plant, both on the upper and under side. The fan is put in motion by the travelling wheel of the drill, and receives its velocity in the usual manner by gathering wheels. The blast thus created by the fan is brought to bear upon the plant, which, yielding to its action, *bends from the current*, which, as it acts upon a falling stream of lime, or other composition, completely covers the plant with the powder. The fly, disturbed by a simple contrivance, hops away, but is at that moment caught by a current of air entering the blast-fan, and instantly destroyed, and thrown out again with violence from the vortex into which it has been drawn. The machines are to be exhibited at the forthcoming annual exhibition at Chester.

Expenses of the Patent Office.—The vote of the House of Commons to defray the expenses of the Patent Office this year is £26,198.

Noxious Trades.—The Public Health Bill, now in progress through Parliament, contains a clause empowering the Privy Council to direct inquiries to be made into the existence of trades, factories, &c., of a nature hurtful to the public health. Lord Wynford (21st July) suggested that some provision should be introduced into the measure by which nuisances of that kind should, after proper inspection, be "suppressed," either with or without compensation.

The Smoke Nuisance Abatement Bill has been (21st July) withdrawn.

Steam Sledges.—Letters from St. Petersburg state, that a Polish exile in Siberia has invented a means of applying steam power to the traction of sledges, by which journeys may be rapidly made on the frozen snows, and the Steppes covered with frozen snow, which abound in the Russian dominions.

RAILWAYS, &c.

Portuguese Railways.—About 50 kilometres of the railway on the south side of the Tagus, between Barreiro and Vendas Novas, have been opened for public traffic. Of the line north of the Tagus favourable reports have been received.

Italian Railways.—The Tunnel through the Apennines, on the Nola and Sanseverino railroad, 1,670 feet in length, has been inaugurated.

Communication with Guard, &c.—The new method, patented by Mr. Boncroft, is intended to establish instant communication of danger or accident between passengers and engine-driver and guard, either separately or together, and from guard to engine driver, and *vice versâ*. In case the axle-tree should break, or a carriage become detached, a strap is tightened or broken, and an alarm given to engine-driver and guard simultaneously.

Railway Excursion-Tickets.—At Lambeth police-court three persons have been fined 40s. each, for travelling with expired or altered tickets on the South-Western railway. This species of fraud, it was stated, had been carried on of late to some extent, especially as regards return-tickets for Sunday excursion-trains.

Dangerous Obstructions on Railways.—At Worship-street police-office a boy had been charged with maliciously placing a stone on one of the metals of the North London line of railway. A policeman had witnessed the act, and had taken the offender into custody. The Company, however, appeared disinclined to prosecute, but the magistrate remanded the case, with the remark, "This is a serious matter." On the 9th July, the boy was again brought up by the police, but the Company still declining to prosecute, the magistrate discharged him with a reprimand.

A similar case was tried (July 12) at Northampton assizes, on the Midland circuit. In this instance the offender was a turnpike-road surveyor, who was charged with having, at Boughton, placed several stones on the Northampton and Market Harborough railway, with intent to injure certain engines using that railway. Accused was seen by an approach-boy to lay five or six stones on the line at the time when an engine and truck-train were approaching, saying, "he would throw her off." It appeared that prisoner was drunk on the occasion. The Court took a lenient view of the case; the jury found a verdict of "not guilty," and the prisoner was severely reprimanded and discharged.

Sardinian Railways.—In the Turin Chamber of Deputies the Report on Project of Law has been presented, authorising the formation of a railway from Savona to Turin.

The Panama (otherwise "Interoceanic") Railway.—The Panama Railroad Company have made a reduction of 3-8ths in the rate of freight on pearl-shells *to be transported across the Isthmus*. The Isthmus route will be cheaper than by Cape Horn, besides effecting a vast economy of time.—*Panama Star and Herald.*

[We do not well understand the nature of this *prospective* reduction of rates whilst the railroad in question is as yet but in contemplation.—Ed.]

Railway Receipts.—The traffic returns of the United Kingdom for the week ending 26th June ultimo amount to £471,990, being a decrease of £31,300 from corresponding week of last year. Gross receipts of the eight termini in London, £197,089; decrease, £13,744. Receipts on the other lines of the United Kingdom, £274,901.

Indian Railways.—The line between Khandalla and Poona was opened for all kinds of traffic on the 14th May, Bombay and Poona being thus connected by rail, with the exception of a temporary portcrage of seven miles at the Bhoree-Ghaut, where it will take two years to complete the tunnel. The original opening was in April, 1853.

A preparatory "*official trip*"—our Gallic friends would have styled it an "inauguration"—was made (10th May) on the railroad, right through. The party left the Bhoree-Bhunder Station at 8 a.m., and were back again by 10 p.m. (14 hours), with loss of four hours on the Ghaut Porterage each way.

Trinidad, June 26.—The Guaralara Line of Tramway, principally for transport of sugar, formerly proposed, but subsequently postponed, is now likely to be resumed.

Indian Railroads.—Cost of Earthworks on the Bombay, Baroda and Central India Line.—According to the statement made by Colonel Kennedy to the adjourned annual meeting of this company, held (on the 21st July, ult.) at the London Tavern, the average cost of earthworks on their line had been at the rate of 2d. per cubic yard, while the *minimum* rates of other lines had been from 6d. to 9¾d. per cubic yard. The earthworks of the Madras Railway were executed in a similar way to their own, and they cost about the same per yard.

Native (Indian) Support.—At the same meeting the chairman (Colonel French), alluding to the history of this Company, stated that it was now ten years since he was resident ambassador at the court of a native prince in Baroda, who had paid all the expenses of a survey of part of their line of railway, and was prepared to give the land for 22 miles of its length, and to subscribe a large sum of money to any Company that would undertake its construction; but on his return to Calcutta he (Colonel French) could find no one disposed to assist in the undertaking, till, on his return to Calcutta, he was introduced to Colonel Kenny, and the railway was projected, &c.

Egyptian Railways.—An English Company has lent money to the Viceroy of Egypt, getting a mortgage on the line from Alexandria to Cairo. This transaction has given rise to much angry comment on the Paris Bourse.

Great Russian Railway.—On the 24th June last the first general meeting of the shareholders of this colossal undertaking took place at St. Petersburg. The propositions of the directors were unanimously adopted. The locomotive boiler which exploded recently at the Atlas Works, Manchester, was the last of thirty ordered by the Russian Government for working this line.

The Lyons Railway Company have purchased the small line at Naples, which runs as far as Castellemare, on the bay skirting Vesuvius, and having stations at Pompeiæ and Herculaneum.

Railway Accidents.—The report of the officers of the Railway Department of the Board of Trade on certain railway accidents during January, February, March, and April, 1858, has just been published. The report recommends, *inter alia*, the lengthening of the platforms at certain stations, the better construction of sidings, and the application of additional break-power to carriages on the Dublin and Wicklow Railway; likewise a better station at Wigan, on the Lancashire and Yorkshire line. Great fault is found with the arrangements at Victoria Station, Manchester. The report concludes with various practical hints for the better prevention of accidents, and the improvement of existing railway management.

A fatal Railway Accident occurred on the 30th June, near Carlton, on the Great Northern line. A train was running at from 40 to 50 miles an hour when the tire of one of the wheels of the tender suddenly snapped, and eight carriages were overturned. It was precisely at this spot that, in September last, the accident occurred by which five persons were killed.

Another Accident, attended with the loss of three lives, occurred (8th July) at the Chilham station, on the Ramsgate and Margate branch of the South-Eastern line, about five miles from Canterbury, to a special excursion train for Ramsgate. When rounding a sharp curve, the crank-axle of the engine broke, the tender and carriages swung over the rail, and a fearful smash amongst the carriages ensued. The evidence before the coroner's inquest as to the immediate cause of the disaster, was more than ordinarily conflicting. Verdict, "accidental death," with a strong recommendation "that no train should pass the curve between the whistle-board and the Chilham station at a rate exceeding 20 miles an hour; and that the road be carefully attended to, and kept in good running order and repair, especially the curve."

Railway Killed and Wounded.—From the official report of "Accidents on Railways," recently published, it appears that during the year 1857 there were 25 persons killed and 631 injured from causes beyond their own control; while 23 were killed, and 15 injured, by want of caution on their own part.

The late Accident on the Midland Railway.—The engine-driver of the empty mineral-train which fell down an embankment near Chesterfield, on the 22nd June last, has died of the injuries then received: the stoker was killed on the spot. At the adjourned inquest held (5th July) at the Midland Hotel, the jury returned a verdict of "manslaughter" against the man who is charged with having caused the accident, through his neglect to give the proper signal; and he is on that charge committed for trial.

The Houne's Gill Viaduct, on the Stockton and Darlington Railway, has been opened for passenger traffic. The materials used are three-and-a-half millions of fire-bricks, and one hundred thousand cubic feet of stone of fine quality, hewn from an adjoining quarry. Entire length of the aqueduct, 700 ft.; height, 175 ft.; with twelve arches of 50 ft. span each. Taper piers. The whole completed in fifteen months. Cost, £14,000.

Italian Junction Railways.—At the annual general meeting held at Geneva on the 28th June last, it was announced that the tunnel at St. Maurice was completed. The line connecting the Lake of Geneva with Martigny will be ready for traffic in September. The earthworks between Martigny and Sion are being rapidly completed.

The Lyons and Geneva, and Dijon and Salins Lines are completed.

A Railway struck by Lightning.—The train from Birmingham for Wolverhampton, on the Stour Valley line, was, during one of the recent storms, struck by lightning. The report is described as resembling the crack of 100 rifles exploded close to the train. The engine-driver and stoker were enveloped in a sheet of blue flame. The stoker received a shock on the back of his head which rendered him for the moment unconscious. No one was dangerously hurt. Every person in the train felt the shock.

A Collision, by which upwards of twenty persons were seriously injured, has occurred (19th July ult.) on the London and North Western Railway at Longwood, near Huddersfield. The passenger train from Leeds to Manchester ran into a train of coal waggons, although the danger-light had been put on while the latter were being shunted at the station. The attention of the driver of the passenger train being diverted to some disarrangement of his engine, he did not notice the signal. The engine and three third-class carriages were much injured, and one truck and the guard-van smashed to atoms.

The Victoria Station and Pimlico Railway Bill (as amended) was read a third time and passed in the Lords on the 8th July ultimo, and on the 12th July it received the royal assent. The capital is £675,000, of which the Brighton Railway Company takes two-thirds.

The West-End of London and Crystal Palace Railway Bill was likewise read a third time and passed in the House of Lords, and on the 12th ultimo it received the royal assent.

Rail to the Highlands.—By the recently announced completion of the railway from Nairn to Keith, a through-communication is established by railway from Inverness to London. A locomotive crossing the Spey inaugurated the new road to the Highlands.

An Elephant Railway-Passenger.—Amongst the passengers at the Lyons Railway terminus about a fortnight since was an elephant, booked from Abyssinia, and *en route* for the Bois de Boulogne.

Australian Railways.—Melbourne to Sandhurst (Bendigo), 108 miles. The Government have accepted the tender of Messrs. Cornish and Bruce for the construction of this line, at £3,356,937. The successful contractors have already executed several important works in the colony. On the 1st June last, the first sod was turned by the Governor; the works are to be completed at the end of 1861.

Geelong to Ballarat.—The tenders for this line not being considered satisfactory, the Government have re-advertised it. The guarantees and required conditions were not to the liking of the colonial capitalists.

From Sandhurst to Murray River.—This projected line, through a level country and lands vested in the Crown, although favourably looked upon, is for the present postponed.

The Hudson's Bay Railway (Australia) pays 14 per cent.

The St. Kilda pays rather more than 14 per cent.

The Geelong, although only partially opened [the advices are dated May 15th ult.], and for want of means indifferently managed, "after a starvelling sort of fashion," pays its expenses.

The New Trunk Lines are looked forward to as promising a relief from the present enormous cost of transport (£10 to £18 per ton), and a "national saving of half the expense of travelling."

Geelong to Williamstown, 40 miles. This line has been opened.

The Melbourne to Williamstown, part of the Melbourne and Murray-River line, will be completed in a few months.

Lyons to Bourgoin (Branch), 27 miles. The inauguration, presided over by the Duke de Valmy, President of the Dauphiné Railway Company, took place on Sunday, the 28th June ult.

TELEGRAPH ENGINEERING, &c.

The Atlantic Telegraph Squadron, consisting of the *Agamemnon*, the tenders *Gorgon* and *Valorous*, and the United States frigate *Niagara*, left Queenstown early on the morning of Sunday, 18th July ult., for the mid-ocean rendezvous, to attempt another submersion of the electric cable.

Turkish Telegraph.—The electric-wire for the telegraph from Constantinople to Bassora has arrived at the latter place in two English ships. Owing to some difficulty of transhipment, all the energies of the Telegraph Commission are to be concentrated on the first section—namely, from Ismid to Givas. The order was sent some time ago to have 6,000 posts ready at different parts of the line, and to make the necessary arrangements for the workmen, so that no further delay shall occur. The line will follow the caravan road through Asia Minor by Angora. The jealous policy of the Turkish Government, as regarded the selection of any persons but natives as "linemen," has changed; and Colonel Biddulph has received authority to engage three of them in England.

Late advices from America state, that telegraphic communication with New York has occasionally been materially interfered with by heavy thunder-storms.

The Channel Islands Telegraph Cable, it is now decided, is to be laid down from Alderney to Guernsey, and thence to Jersey, and not, as originally intended, from Alderney to Jersey, and thence to Guernsey.

Default of Railway Telegraph Signals.—The late collision at Flimby colliery, on the Whitehaven Junction line, is officially declared to be due "partly to want of adequate telegraphic signals."

The Atlantic Telegraph Cable—Summary of the Month's Progress.—Advices from St. John's, Newfoundland, received 5th July, announced that a Government steamer was to be dispatched to pilot the *Niagara* as near as possible to the point where it had been decided to land the telegraph cable.

On the 6th July the *Niagara* and *Gordon* had returned to Queenstown with the unwelcome intelligence that, after having paid out in mid-ocean (about 1,000 miles from Valentia) 250 miles of the cable, the latter suddenly parted.

On the 12th July the *Agamemnon* arrived at Queenstown, having left the rendezvous in the centre of the Atlantic on the 6th, after a narrow escape from foundering in a heavy sea and storm on the 20th and 21st June, her coals, &c., having, through the heavy rolling and lurches, shifted and broken away. The electrical instruments all injured.

On the 25th, rendezvous had been made in mid-ocean, lat. 52° 2', long. 33° 18'.

On 26th, first splice made, but cable broke on board the *Niagara*. Same day splice renewed, but again broke on the 27th.

On 29th, at night, third splice parted at about 6 fathoms below stern of *Agamemnon*. 146 miles of cable paid out, and strain on wire being only 2,200 lbs.

The "Times," in a leading article, has suggested that, in any future attempt with the Atlantic Cable, the *Leviathan* (now the *Great Eastern*) should be fitted up for the operation of submerging the cable. Subsequently, in the House of Commons, on the 9th July, the Chancellor of the Exchequer, in reply to a question by Mr. Griffiths on the subject, said the Government had not the intention of making use of the *Leviathan* to lay down the Atlantic Telegraph Cable.

[We think it but fair to state that, whatever may be the practical value of this idea, the merit of its first suggestion is not due to the "Times." We have elsewhere, in our present Number, entered more in detail into this subject.—Ed.]

Telegraphic Communication, it is understood, is to be established by the French Government between every harbour on the French coast. Electric cables are to be laid all along the shore; and by this means, Dunkirk, Havre, Bordeaux, Marseilles, Brest, Cherbourg, Rochefort, and Toulon, will be enabled to correspond together, without having to send dispatches through Paris, as is the case at present.

The Electric and International Telegraph Company intend to submerge, during the summer, a new submarine telegraph cable, containing several wires, from a point between Lowestoft and Orfordness, on the Eastern Coast, and Landvoort, Holland. The cable will be 130 miles long.

Australian Telegraph Lines—Melbourne, 15th May.—"The electric telegraph is complete to Adelaide, but not yet opened. The line to *Sydney* nearly finished."

Projected Telegraph from Ragusa to Alexandria, by way of Corfu and Candia.—The British Cabinet have informed the Cabinet of Vienna that it does not object to an electric cable being laid down between Ragusa and Corfu, and Corfu and Zante, *at the risk and expense of Austria*. It is also willing to join Austria in guaranteeing 6 per cent. to any company which will undertake to carry the telegraph from Corfu to Candia and Alexandria.

Recovery of Lost Electric Cable.—The two electric cables which Mr. Brett endeavoured in vain, about two years ago, to lay down between Spartivento, Bona, and Gallita, have, according to "Galignani's Messenger," been discovered and taken on board an English steamer, which arrived at Elba last week.

MILITARY ENGINEERING, &c.

Terry's (of Birmingham) Breech-loading Rifle-Carbine, detachable, so as to form a pistol also, has been under test on board Her Majesty's ship *Excellent*, from May 10th until the present time, during which period 1,800 rounds have been fired from it with unprecedented accuracy, at various ranges, without cleaning the weapon, which, notwithstanding, gives no recoil. A written certificate to this effect has been given by Captain Hewlett, C.B., who superintended the trial. The advantages of the new weapon over the old pieces are 3 lbs. less in weight, and five shots to one in time of firing, giving it the advantages of a revolver with a tremendous range (the practice on the 21st July ult., at the Camp at Browndown, at 700 and 800 yards, is described as marvellous), and no necessity for cleaning out under about a couple of thousand rounds.

Mammoth Mortar.—By special permission of the Secretary of State for War, the officers of the Special Committee of Woolwich Arsenal assembled in Woolwich Marsh on the 21st July ult., to witness another proof of the durability of Mr. Mallet's Mammoth Mortar. The trial was intended to consist in firing ten rounds, the charge to commence with 40 lbs. of powder, a straw wad, and a 36 in. shell, the shells averaging about 2,376 lbs. weight; each succeeding charge of powder to be increased 10 lbs. One hundred and seventy bags of powder, containing 5 lbs. each, and a supernumerary number of the huge shells, were accordingly served out and conveyed to the spot for the occasion. At 12 o'clock a gunner was introduced into the mouth of the mortar, and he placed in it the first charge, contained in eight separate flannel bags. The loading occupied about 30 minutes, and the first shot was pronounced to be highly satisfactory, the flight extending over 1,700 yards, and the shot alighting in an almost direct line with the butt. The second shot, containing 50 lbs. of powder, was considered equally satisfactory, taking a flight of about 400 yards beyond the first, and marking the spot where it fell by casting up a mound of earth and gravel, and burying itself many feet beneath. The third charge was about to be introduced when indications were perceived of some derangement of the rings forming the barrel of the mortar, by the displacement of some of the cotters or wedges. On the application of the hammer, one of the cotters was found to be broken. It was therefore judged unsafe to proceed with the trial, and the continuation of the experiment was postponed.

Novel Application of Artillery to Road Making.—A road contractor, in the department of the Arriège, near the Pyrenees, having lately found the process of blasting an overhanging rock rather difficult, and a mortar battery of the 10th Regiment happening to be passing along, he telegraphed to Paris for leave to open fire upon a crag 60 metres above the road, over which it impended. A few rounds of 10-in. shell soon brought the entire mass into fragments. About ten minutes sufficed for the operation.

"Enfield" and "Whitworth" Rifles.—Two Committees are now sitting to inquire into the subject of *firearms*, to one of which is submitted the question of the relative merits of the Enfield and Whitworth Rifles.

Blasting Operation.—"Vienna, July 4th. The blasting of the *Stuben Gate*, which took place at eight o'clock yesterday evening, was completely successful. A great mass of masonry seemed to be gently lifted, and when the dust had subsided it was seen that the whole of it was crumbled."—*Times' Vienna Correspondent.*

A New Bullet-Casting Machine, the invention of a Berlin engineer, has attracted some attention in military circles. It is spoken of as likely to be of great use to troops in a campaign, being easily worked by two men, with comparatively small consumption of fuel, and to be very portable. It can turn out 4,000 Minié rifle bullets per hour.

The New Gun Foundry at Woolwich.—About half a dozen iron guns, the first-fruits of the new establishment, were, on the 8th July, conveyed to the proof-butt, at the extremity of the Arsenal, by means of Boydell's "traction engine," to be submitted to a primary proof, namely—to be fired with two rounds of powder and solid shot. The difficulty of arriving at a correct fusion of metals is now, it is hoped, overcome, and the enormous cost of the new establishment seems likely to be in some measure compensated. The results of the improved system of tests—namely, by fire, water, sun, searching, &c.—through which the guns must be rigidly put before being passed for service, are looked forward to with interest.

Mortar-Boats.—The Admiralty have ordered eight of these destructive engines, built for the last Russian war, to be sent from Sheerness to Chatham Dockyard, for preservation till their services shall be again required.

A Novel Military Manœuvre.—During some military exercises, under General Mellinet, performed at the Champ de Mars, a few days since, 200 men of the 2nd Regiment of Grenadiers swam across the Seine, firing at the same time on the opposite shore. The movement was well executed, and without any accident.

Defective Ammunition.—In the House of Commons (July 9), Lord Stanley, in reply to a question on the subject, stated that the ammunition sent to India had been found defective, and steps had immediately been taken to remedy the evil.

On the same occasion, General Peel announced that the new Gun Foundry at Woolwich, far from proving a failure, promised to become a decided success.

Fortifications of Lille.—By an Imperial Decree, countersigned by the French Minister of War, and in order to make room for the new improvements, the ancient fortifications of Lille, so renowned in military annals, and famous for successful resistance to Marlborough, in the bygone system of military tactics considered as impregnable, are to be levelled with the ground.

Bullets Perforated by Insects.—A new devastator of ordnance stores, and whose very existence has been hitherto, we believe, unsuspected by naturalists, has lately formed the subject of scientific inquiry. In September last, Marshal Vaillant presented to the Academy of Sciences some *leaden bullets* which had been brought back from the Crimea, *perforated by an insect* unknown in France, stating, at the same time, that he had applied to St. Petersburgh for information on the subject. The following is an abstract of the result of his enquiries:—The phenomenon of the perforation of bullets has not been observed in the Russian army. The insect which caused the perforations in the bullets of the French army is the larva of the *urocerus juvencus* (of Linnæus). This insect has not hitherto been met with in the Crimean peninsula by Russian entomologists, and appears to be very rare, even in Russia Proper, but is common in Bessarabia, Germany, Sweden, *and England* (?), where it does much injury to the fir and pine forests. In France it has been met with in the Jura. M. Hartig has described it at some length in his work on the *Tenthredides*. The *urocerus* which perforated the French bullets was imported from France in the wood of which the boxes containing the cartridges were made, and corroded the lead with its mandibles, in order to lay its eggs in the cavity; not to satisfy any craving for that metal, but merely operated upon it as it would have done on wood, having been forced to do so *because the bullet lay in its way*. The larvæ of the *urocerus* did not feed upon the lead which they had scraped off with their jaws; and the perfect insects could not feed upon it either, since they were found dead in the galleries bored by the larvæ.

Flight of Shells, &c., Photographed.—Some recent photographic experiments, in connection with mortar practice, although their immediate scientific application may not be as yet clearly apparent, seem, nevertheless, worthy of passing notice. A letter from Mr. Thomas Kaife, of Vanburgh House, Blackheath, to the "Times," describes one of these experiments made by the writer on Monday, the 28th June ult., at twenty minutes past 11 a.m., on Woolwich-common. A 13 in. shell was fired from the mortar-battery by men of the Royal Artillery. The shell, weighing 200 lbs., was ten seconds in traversing the air, and fell within two yards of the Flagstaff, distant from the battery 600 yards. The *photo-stereo*, taken *as the shell emerged above the smoke*, showed 3-8ths of an in. of the projectile's track, commencing at the distance of eighteen times the shell's diameter above the mortar, and 1 1-8th in. visual distance above the head of the superintending officer in front. This, the writer believes, is the first time a mortar-shell has ever been photographed in its *ascending flight* sufficiently intense to print from. [May we not here have the elements of a means of determining by actual observation, and more accurately than by mathematical calculation, the true curve described by projectiles in their flight, and thus obtain a valuable adjunct to the art of gunnery?—Ed.]

Revolvers for the French Navy.—The French Marine Department has accepted a contract for the supply of six-barrel revolvers for the naval service.

MARINE ENGINEERING, SHIPBUILDING, &c.

The Sunken Vessels Recovery Company having failed as a speculation, its affairs are now before the Courts of Law on disputed contributory questions.

A New Diving Apparatus has just been tried at Paris with success. It is a modification of the well-known watertight helmet for divers, supplied with an india-rubber breathing-tube, in communication with a pump worked by two men. The principal novelty appears to consist in a heavy leaden collar annexed to the metal helmet, to facilitate the descent of the operator. Weight of the helmet, including the collar, 40 kilogrammes (about 80 lbs.). The experiments took place at the Pont-Royal. The diver explored a considerable portion of the bed of the Seine at about 15 ft. below the surface of the water, and brought up several articles, including a stone, weighing 50 kilogrammes. Being an expert swimmer, he took off the apparatus under water, rose to the surface, and put it on again under water, to the great surprise of the crowd.

Progress in Steam Navigation.—Since 1850, the time occupied by steamers crossing the Atlantic between Liverpool and New York is shortened by two days. The amount of fuel consumed in the voyages so shortened is twice that required formerly by the steamers that ran between the two places named.

New Line to the Azores.—The new steamer, *W. S. Lindsay*, intended to commence the line to the Azores, has arrived at Lisbon; she is in a few days to hoist the Portuguese flag, and to change her name to that of *Donna Estaphania*.

Raising the Sunken Ships at Sebastopol.—The American contractors have had to abandon their contract to raise these vessels, which are found to be almost entirely worm-eaten. Notwithstanding which, another set of workmen, under a Mr. McGowan, have entered into arrangements with the Russian Government to clear the Port of Sebastopol of the hulls of the sunken ships.

The "Leviathan" (now registered as the *Great Eastern*) has been visited at Deptford by the Queen and Prince Consort, accompanied by the King of the Belgians. Henceforth the monster steamer is to lose its popular *sobriquet* of *Leviathan*, and to be known by its original name of the *Great Eastern*. The proceeds of the public exhibition of this vessel will, as the Directors announce, be set aside for the benefit of the Poplar Hospital and the *Dreadnought*.

The steamer *Cagliari* reached Genoa on the 23rd June last, having on board the British Consul at Naples, by whom the vessel and crew (17 men) were officially consigned to the Sardinian authorities. The following day the steamer was delivered up to Messrs. Rubattini and Co., the owners.

Life Boats.—From returns furnished by the officers of the coast-guard, and by Lloyd's agents, resident on the coasts of the United Kingdom, read at a meeting of the National Life Boat Institution (1st July ult.), it appears that 24 additional life-boats are required on the English, 21 on the Scotch, and 19 on the Irish coasts, making a total of 63 additional life-boats required.

The "Penelope," 16, paddle-wheel frigate, now at Portsmouth, is to be broken up. She was the first attempt at a "big" war-steamer by conversion, having been an old 42-gun frigate. She was lengthened 60 ft. amidships.

Screw Steam Ship "Sarah Sands."—The disastrous burning of this fine vessel 400 miles from the Mauritius, on her way to Calcutta, some time since, has again occupied public attention. The Board of Trade, who had asked for the names of the crew of this ill-fated vessel, in order, as it was fully understood, that some suitable reward should be granted them for their courageous conduct on that trying occasion, have just announced that a reward cannot be granted, as it might lead to establishing a mischievous precedent.

The "Dreadnought" Hospital Ship.—The Admiralty have issued orders for extra moorings to be laid down at Greenhithe, for the temporary station of this floating seaman's hospital, which, in consequence of the fœtid state of the Thames, is to be removed to a purer atmosphere.

Dutch Iron Steamers.—The Flemish and Antwerp Journals speak enthusiastically of the exploits of an iron Dutch-built steamer named the *Telegraaf No.* 3, than which, according to the quoted testimony of the Belgian pilots—"there is no steamer in Europe that runs faster, if so fast," adding—"the speed of this steamer is so extraordinary that it *throws the railway into the shade*." This vessel was built (in April last) by Messrs. Fop, Smit, Jun., and Co., at their shipbuilding yard, at the Kinderdyk, near Rotterdam (as was also its twin iron steamer *Telegraaf, No.* 4), for passenger and goods traffic between Rotterdam and Antwerp. A correspondent of the "Times" (5th July), alluding to the circumstance, hints at the necessity of our own iron shipbuilders being on the alert.

Wreck of the Steam Ship "Ava."—The official inquiry recently held at the Greenwich Police Court, touching the loss of this vessel, near Trincomalee, with treasure, the mail, and numerous passengers on board, has just terminated. The Report of Mr. Selfe (Captain Walker being Assessor) to the Lords Commissioners of the Privy Council for Trade, states "that the loss of the *Ava* was caused by the default of Captain Kirton, the master;" the default alluded to had been previously stated to be "not heaving the lead," and "neglect of soundings," a strong current having set in, and the vessel running 13 knots an hour when she struck.

Steamers for the Niger Expedition.—The small *steel* screw steamer, of 170 tons, the *Rainbow*, built by Mr. J. Laird, of Birkenhead, in connection with the Niger exploring expedition, was subjected to a probationary examination previously to her departure for Africa. In her trial trip she made the average speed of from 12 to 13 miles an hour.

The Launch of the "Windsor Castle," war steamer, of 116 guns, is to take place on the 26th of next month. She is still on slip at Pembroke, and has been altered and fitted for the screw.

The Screw Steam-Ship "Benares," belonging to the Peninsular and Oriental Company, has undergone a severe trial at Cork, to test the improvements made in her machinery since her first trip to Alexandria. Her average speed was found to be 12·54 knots per hour on a run of 321 miles. Ship and machinery constructed by Messrs. Todd and McGregor, of Glasgow; fitted with Lamb and Summer's patent boilers.

Steel Steam-Yacht.—A steam-yacht, built of Mr. Clay's puddled-steel plates, the same as those used in the building of the Niger expeditionary steamer *Rainbow*, was launched on the 14th July ult. from the yard of J. Laird, at Birkenhead. The yacht is 96 ft. long, 16 ft. 6 in. beam, has a tonnage of 131, and is supplied with a high pressure engine of 25 H.P. It is a pleasure yacht for the Duke of Leeds, and is named the *Deerhound*; fitted with a lifting screw, schooner rigged. She is considered as a beautiful model, and she affords the first instance of the introduction of the new material, *puddled-steel plates*, in the building of yachts.

Paddle and Screw Steamers for the Indian Transport Service.—The Admiralty have approved of a plan (by a company) to establish a monthly line of steamers between Southampton and Calcutta, round the Cape, specially constructed and fitted for transport service. These vessels are to be of 5,345 tons, 432 ft. between perpendiculars, 50 ft. beam, and 43 ft. depth, fitted with paddles and screw, like the *Leviathan*. The contract minimum rate of speed is to be 300 miles per day, or 42 days for the entire voyage. They will (each vessel) carry 1,000 men in comfort and order, without packing. The company merely require a contract binding Government to give them 15,000 soldiers a year (10,000 out and 5,000 home), at the rate of £20 per head.

The New Line from Galway to America.—In the same advices, the arrival at New York of the *Indian Empire* steam-ship from Galway, *viâ* Halifax, is announced. [To the perils and adventures of this fine steamer—the pioneer of the newly-attempted route—we adverted to in our last Number.—Ed.]

The Nicaraguan Ship or "Inter-oceanic" Canal.—In late advices from New York to 7th July ult. it is stated, that the American President has determined on having the new ship canal from ocean to ocean, otherwise "the transit route," opened, and to sustain any company that has a valid right. Vessels of war were stationed at each terminus.

Loss of the "New York" Steamer (tonnage, 2,094), on the 13th June last.—A Court of Inquiry, instituted by order of the Board of Trade, under the Act whereby captains or masters and mates of vessels are made amenable for the loss, by neglect, of any ship whilst under their command, has been recently held at Cambleton before two presiding justices, and Captain Harris, R.N., the Nautical Assessor for the Board of Trade. It resulted in the acquittal of the captain from blame, the Court being of opinion that the cause of the wreck was some defect in the compasses, over which he had no control.

Austrian (incipient) Navy.—Amongst the modern efforts at maritime power made by certain European states hitherto almost exclusively emulous only of *military* display, we may class the recent announcement in the foreign journals, that "Austria has launched from the stocks at Pola, in the Adriatic, a 90-gun ship of the line."

Death in a Diving Apparatus.—On the 17th July ult. a mason named Affer, employed as a diver in building the new Admiralty Pier, at Dover, lost his life by opening a valve in his diving dress, by which the water was allowed to get into his helmet. When lifted up out of the water he was quite dead.—*London Evening Paper*, 19th July. [We do not clearly perceive on what evidence it is so confidently stated that the poor fellow himself "opened the valve;" why not admit at once that the apparatus might possibly have got out of order?—Ed.]

The *Industry* steam-vessel is ordered to be coated with a preserving varnish, patented by M. Sczerelmy, a Hungarian gentleman, who has been directed by the Admiralty to carry on experiments at Woolwich Dockyard. [This is another application of the material we have elsewhere alluded to with reference to the new Houses of Parliament. A still further use for it is talked of—namely, for the preservation of boilers, *as it cannot be destroyed by fire*.—Ed.]

Caution to Divers.—Another accident has occurred to a diver engaged at Erith in raising the wreck of the *Lightning* brig, which recently went down in deep water in that locality, as mentioned in our July Number, when referring to Bishop's Patent "Derrick." Instead of descending gradually, in the usual manner, the man, it appears, dived down suddenly to a depth of 6 fathoms (36 ft.); the concussion caused a rapid condensation of the air, which, reacting, as it is imagined, on the lungs of the unfortunate diver, produced congestion on the brain, and consequent symptoms of apoplexy, from the effects of which it was feared he would not recover.

GAS ENGINEERING—(HOME AND FOREIGN).

Improvement in Producing Gas.—Messrs. J. Alphonse (Miner) and F. Canal, of Paris, have obtained provisional protection for the use of tar and other residues arising from the manufacture of gas, and other tars, resinous or fatty matters, mixed with thin shavings, chips or pieces of wood, and sawdust of all kinds of wood. The mixture is distilled in ordinary gas apparatus, and the gas purified by ordinary means. By this process, says the "Mining Journal," a very pure and cheap gas is obtained, of good lighting power. The proportions of the various substances employed are as follows:—500 parts of the residue of gas or of fatty matter; 1,000 parts of sawdust of any kind of wood; 500 parts of shavings, chips, or pieces of wood of any kind. These proportions may be varied according to the quality of gas to be produced.

Gasometer Explosion at Cardiff.—The large gasometer of the Cardiff Gas Works, one of the largest in the kingdom, according to the local "Guardian," has exploded, or at least been totally destroyed by the sudden combustion of the whole mass of gas contained in it.

The Norwich (Gas) and Northampton (Gas) Bills having respectively passed through Parliament, received on the 12th ult. the Royal Assent by Commission.

The London Chartered Gas Company have recently, through their secretary, announced to the public that no "blue billy," or gas-refuse of any kind, has been suffered to enter the Thames from their works for the last thirty years.

A Gas Explosion occurred (5th July) at Park House, Hampstead-road. On the maid-servant entering the parlour to ignite the fire with a lighted candle in her hand, the gas, which during the night had escaped from the chandelier, exploded with terrific violence, dangerously injuring the girl, and completely destroying the valuable contents of the room. This accident is similar to one which occurred about eight months ago at the house of Mr. Edwin Clark, of Britannia Tubular Bridge celebrity, by which that gentleman was severely singed, having nearly lost his eye-sight, and was blown by the explosion through two doorways, along a passage, and forced against the wall of a room nearly 50 ft. from that in which the explosion took place.

Another Explosion of Gas took place on the 17th July ult., at the "Bell's Life" office, Strand, by which several persons were injured. The mains of the gas were being relaid, and a very strong smell of gas arose from the cellar, causing the sufferers to go down stairs *with a lighted candle*, to see where the escape came from. A terrific explosion took place, knocking down the incautious explorators, two of whom were frightfully burnt.

WATER SUPPLY—(METROPOLITAN AND PROVINCIAL).

Consumption of Water in London.—According to the evidence of Mr. Bateman, Civil Engineer, given before the Parliamentary Thames Committee on the 6th of July, about eighty million gallons of water are consumed in London daily: about half that quantity is taken from the river Lea [and New River?—Ed.]. The remaining forty millions of gallons are taken daily from the Thames.

Artesian Well at Ostend.—The sinking of this well is now looked to with increased anxiety ever since the recent and still existing dearth of water on the Continent. The work proceeds at the rate of two metres and a half in twenty-four hours. After meeting with beds of shell and agillaceous soil at the depth of 33 metres, the deposit, at 68 metres below the bed of the German Sea, is found to be pyrites.

France.—During the first week of July the waters of the Seine fell very nearly to the lowest level known, that of 1719, which is taken as the *minimum* level or zero of the modern Seine Index.

Madrid.—The inauguration of the new works for distributing water in the Spanish capital has just taken place, amidst great public rejoicings. These works, the expence of which is estimated at 126,000,000 reals, include a fine jet, 81 ft. high.

Public Drinking Fountains.—The inhabitants of Ann-street, Birmingham, having a balance on hand remaining from the sum raised for decoration, &c., during the Queen's late visit, have resolved to appropriate it to the erection of a fountain in the street similar to the one erected in Liverpool by Mr. Melly.

Paris Water Supply.—Mr. Haywood, engineer to the City Commission of Sewers, in his late evidence before the Thames Parliamentary Committee, states that the water-supply of Paris is not one-fourth sufficient for the consumption of the population.

The following Bills, relating to water supply, received (12th July) the Royal Assent by commission:—The Manchester Corporation (Water), The Bury Radcliffe (Water).

East London Water Supply.—The supply of water from the East London Water-works exceeds, it is said, 16,000,000 gallons per diem, at present obtained from the river Lea. The Company has contracted with the West Ham Local Board of Health to supply small cottages with water at the rate of 2d. per week, or 8s. 6d. per annum.

At Hitchin the legal disputes between the Local Board and a claimant on the water of the local river, used from time immemorial, without stint, by the inhabitants, seem to have led to the dissolution of the Board altogether.

Artesian Well at Swindon.—The Great Western Railway Company have discovered a fine spring, by boring, at New Swindon. The spring throws up eight gallons of water per minute through a $3\frac{1}{2}$-in. tube. At a boring depth of 141 ft. a copious stream was thrown up some feet above the ground. A well of 6 ft. in diameter is being permanently sunk.

Purification of the Thames.—A correspondent (N. R.) of the "Times" (22nd July ult.) remarks, "There is only one insuperable objection to Admiral Sartorius's plan for allowing Southampton Water to flow into the Thames above London, which is, that water will not flow up hill. An Admiral, in 1849, proposed to the Metropolitan Commissioners of Sewers that they should drain London by a main trunk sewer, to open into the sea at Beachy Head. His plan had in its favour the law that fluids flow down hill."

HARBOURS, DOCKS, CANALS, &c.

A New Method of Navigating Canals has been discovered by M. Leterre, of Saint Quentin, and tried, it is said, with success. By means of a fixed wheel, turned by one man, a current is established in less than ten minutes throughout the whole length of the canal, so strong as, without any other motive power whatever, to carry forward a barge with its full load. The first experiment was tried on the ditch surrounding the estate of Saint Claude, near the Bridge of Rouvroy, under very unfavourable circumstances; nevertheless, M. Leterre had his paddle-wheel set in motion, and in less than four minutes a laden barge followed the course of the current formed by the revolution of the (fixed) wheel for a distance of 1,074 metres (about 3,490 ft.).

LIGHTHOUSES.—In the House of Commons (July 1), on the question of appointing a committee on this subject, the Government announced that there was no intention of delaying the appointment of such committee, the press of public business alone having hitherto prevented more attention being paid to the subject.

HARBOURS OF REFUGE.—Amongst the undertakings needful to be executed as national works, certified by the Commissioners in their recent report, are—a harbour of refuge on the north-east coast of Scotland, to cost from £80,000 to £335,600, according to the site selected; one on the north-east coast of England, at estimated cost of £800,000 to £860,000; extension of the Harbour of St. Ives, at £174,000, or, if Padstow be adopted, of £35,000 only; one at the Mumbles, or some place in the Bristol Channel, at the cost of £300,000; improvement in the Harbour of Carlint, or Carlingford, at cost of £20,000; ditto of harbour at Waterford, at cost of £20,000; the construction of a harbour of refuge at the Skerries, Portrush, at cost of £100,000; a pier in the Isle of Man, at £40,000; making *a grand aggregate sum* of £2,000,000, or, if spread over ten years, at the rate of £200,000 a year. Recommend that no charge should in any case exceed *one penny* per ton upon all ships entering or clearing from British ports, and passing the harbours of refuge in their course. Approve the plan of Mr. Rendel, as used at Holyhead, or as modified by Mr. Abernethy, as the best, in every respect for the construction of harbours of refuge.

THE NEW CANAL OF ISABELLA II., MADRID.—The solemn inauguration of this great utilitarian undertaking, which, by changing the bed of the River *Lozoya*, is to bring its waters to the Spanish capital by a canal nearly 50 English miles in length, has recently taken place. The supply of pure water to Madrid will be increased in nearly sevenfold proportion to its former supply. 32,000,000 francs have been spent on the works, which have been seven years in progress, being all directed by Spanish engineers, in whose honour a grand banquet was given on the occasion at the palace.

TWO VESSELS WRECKED IN THE EAST INDIA DOCKS.—A disaster, unprecedented, perhaps, in its kind, has recently (July 1st) occurred in the East India Dock entrance, where two brigs, the *Ocean*, of Shoreham, and *Lustre*, of Shields, got jammed together in the entrance lock at Blackwall, and filled with the tide. They were subsequently raised, and towed out to the river, clear of the lock. They are described as having all the appearance of wrecks.

THE TEMPORARY NEW PIER AT HOLYHEAD, for which the House of Commons voted £21,000, is to be immediately commenced for the reception of the new mail steamers now being built for the Holyhead and Dublin Station.

The following DOCK, HARBOUR, AND CANAL BILLS having passed through the routine ordeal of Parliamentary stages, received (12th July) the Royal assent by commission:—The Wexford (Harbour Embankment) Bill, the *Andover* (Canal and Railway), the *Mersey* (Docks and Harbour, New), the *Mersey* (Dock and Harbour, consolidation of Acts).

IN THE HOUSE OF COMMONS (sitting of the 10th July ult.), Mr. Wilson, as Chairman of the Committee on Harbours of Refuge, announced his intention to bring the subject before the House this Session.

THE DEPTFORD DOCK *and Victualling Yard* is henceforth to bear the name of the VICTORIA DOCK and Victualling Yard.

IN THE HOUSE OF COMMONS (sitting of the 19th July ult.) Sir J. Pakington intimated the intention of the Government to appoint a Royal Commission on the subject of Harbours of Refuge.

THE NEW HARBOUR AT CHERBOURG.—This magnificent harbour, at the inauguration of which (now decidedly fixed for the 4th of August next) the Queen of England is to be present as the formally invited guest of the Emperor of the French, is thus described in the "Moniteur de la Flotte":—"It is 400 metres (1,300 ft.) in length, 200 metres (650 ft.) in width; the height of the quay is 18 metres (58 ft. 6 in.), and the depth of water 9 metres (29 ft. 3 in.). It has been hollowed out, not merely of the rock, but of the granite itself by a mining system not tried heretofore, or, at least, of which the prodigious results had not been as yet tested. * * * On the stocks of this basin the steam-ship *Ville de Nantes* has been built. Some days previously to the inauguration (and launch of the new vessel in presence of their Majesties), the railway will be opened for public accommodation. * * * The last of the docks will open its sluices to the sea the very day on which the descendant of the *modern Charlemagne* (!) renews implicitly with the English people, in the person of its Sovereign, a treaty of forgetfulness of the past and of friendship for the future." The Emperor and Empress will probably pass the day on board the *Bretagne*, a ship carrying an Admiral's flag; while Queen Victoria will remain during the day on board the English vessel carrying her flag."

CANALS *v.* RAILWAYS (France).—The Council-General of Bridges and Causeways of the Eastern Department have pronounced in favour of the proposed canal (for coal transport, &c.) of La Sarre, in preference to the project of a railway from Cocheren to Sarrebourg.

RAMSGATE HARBOUR.—The Revenue of the Royal Harbour of Ramsgate Trust in the year ending Midsummer-day, 1857, was £18,335, and the expenditure £17,591, according to accounts presented pursuant to Act of Parliament.

A MODEL IN RELIEF OF THE WORKS OF CHERBOURG, in the proportion of a mille mètre to a mètre, has been ordered by the French Emperor to be prepared as a present to the Queen of England, on occasion of her visit to view the Inauguration Fête of the 4th of August next.

EMBANKMENT OF THE THAMES.—In the House of Commons (15th July), Sir B. Hall, after alluding to "the absurd projects" for the purification of the Thames "submitted to the Committee up stairs," said: "He entertained a strong opinion that some day or other a much greater work must be undertaken—one which could not be borne by the metropolis only—he meant the *Embankment of the Thames.*"—(Cheers). "Every civil engineer who had investigated the subject arrived at the same conclusion, and believed that this was the only way in which to prevent the exhalations which would constantly arise from the river banks."

BRIDGES.

TUBULAR BRIDGE.—The first tube of the Albert Bridge, to join Devonshire and Cornwall, mentioned in our "Notes and Novelties" for last month as having been raised to its position, weighs between 2,000 and 3,000 tons, and its centre is about 230 ft. above the bed of the river. For subsequent operations, see "Royal Albert Bridge."

STEAM BRIDGE.—It is intended to run a railway bridge across the mouth of Medina River, in the Isle of Wight, to connect East with West Cowes.

THE NEW CHELSEA BRIDGE.—In the House of Commons (July 1) the second reading of the New Chelsea Bridge Act Amendment Bill was carried by a vote of 161 against 96.

THE CUBA RAILWAY BRIDGE.—The contract for constructing all the bridges along the line of railroad through the Island of Cuba has been disposed of at 1,500,000 dollars to Mr. Ballmon, road-master of the Baltimore and Ohio Railroads.

THE KEHL BRIDGE.—It is settled that the new bridge over the Rhine, at Kehl, shall be fixed in the middle, and moveable at the extremities. The Junction Railway, between Kehl and Strasbourg, which is to cross the new bridge, is to have double rails. The now-existing pontoon bridge will remain.

THE YARMOUTH BRIDGE BILL (July 12th ult.) received the Royal Assent by commission.

THE ROYAL ALBERT (TUBULAR) BRIDGE.—On the 10th July the second tube of this railway bridge, across the Tamar at Saltash, was safely lodged on the river piers. In the absence of Mr. Brunel the operations were conducted by Mr. Brereton. This tube is 455 ft. long, 17 ft. wide, and 12 ft. deep, and is estimated to weigh about 1,200 tons. The camper or rise is 28 ft. It was sustained at each end by a heavy framing of timber, or pontoons. The proceedings were conducted by coloured signals, exhibited on the floating work. Five substantial vessels, possessing powerful purchases, were firmly moored at well-selected points. They were lent by the Admiralty with a number of blue-jackets from Her Majesty's ship *Exmouth*. The ponderous mass had first to be detached from the shore and worked up the river, clear of the recently-erected eastern pier, which was close to the lower pontoon. The upper part was then gradually guided westerly to the middle of the stream, and after the tide had risen sufficiently, the two ends were quietly adjusted in their proper position. When this was accomplished, the feelings of the large body of men employed found vent in a hearty and heartfelt cheer. Among the distant visitors was Captain Harrison, of the *Great Eastern* steam-ship. The completion of this bold undertaking will perfect the difficult junction of Cornwall with the South Devon and Great Western lines.

THE NEW VICTORIA RAILWAY BRIDGE.—The Government opposition in Parliament has resulted, as our readers will perceive, not in the defeat of the Bill, but in a trifling modification of its "æsthetic" details. The plan is to be a little changed. The railway bridge was originally intended to be placed about 160 yards below the present handsome but toll-paying one, and the two bridges were to be exactly parallel to each other. The new bridge, on the south side, is to be a few feet from the existing one, whilst, on the north side, it is to be many more feet distant; in short, the bridge is to cross the river, not at right angles, but "askew."

THE NEW WESTMINSTER BRIDGE.—The works at last are rapidly progressing. The new bridge is to be double the width of the old one, and the site of the increased width is on the south or upper side, immediately under the clock tower of the new Palace. The abutments have been for some time finished. The "Old Red Lion" (eastern end), and "Denton's Hotel" (western), will have to be removed, in order to increase the width of the approaches. The piers are 11 ft. 6 in. wide, and will ultimately be 100 ft. in length, and each will stand on 233 piles of iron and elm, driven 19 ft. into the London clay, the superincumbent material being first concrete and then granite, bound together internally by iron clamps embedded in the stone. The waterway, abridged to a considerable extent by the new works, will still be nearly 800 ft. It is to be spanned by seven arches, elliptical in shape, and the material iron, the spandril and haunches being of cast, and the crown-pieces of wrought metal. The sessional Parliamentary vote for the new bridge is upwards of £100,000.

THE NEW CHELSEA BRIDGE is to be free of toll on Sundays in future, as likewise on Easter Mondays and Whit Mondays.

BOILER EXPLOSIONS.

A FEARFUL BOILER EXPLOSION has taken place (July 2) at the Atlas Iron Works (Messrs. Sharp, Stewart, and Co.), Manchester, whilst testing for high pressure a new railway locomotive boiler for the Russian Government (cylindrical, of largest dimensions, plates 5-8ths of an inch thick). One of the plates gave way along the line of rivets, and was blown to a great distance, killing nine persons, amongst whom were Mr. Forsyth, the well-known scientific manager of the works, the foreman of the boiler makers, the foreman of the engineers, two gentlemen, apprentices, one rivetter, and the agent or inspector for the Russian Government. The pressure on the valve five minutes before explosion was 120 lbs. to the square inch. Mr. Fairbairn's report ascribes the accident to the weakness of the boiler plate which was driven out, and not to excessive pressure of steam. His expression in the report of his evidence at the Coroner's inquest was, "unforeseen and undiscoverable weakness in the boiler plate, no blame attaching either to the makers of the engine or the manufacturers of the plate; and the jury found a verdict simply of "Accidental death."

ANOTHER BOILER EXPLOSION occurred on the 3rd July at the mining village of Victoria, South Wales, namely, at the "puddling forge" of the Victoria Iron Works. Four men killed, and several wounded. Caused by the recklessness of the engine-driver (one of the killed), who actually sat upon the lever of the safety-valve in order to prevent the blowing off of the steam. Boiler 40 ft. long, and 7 ft. in diameter.

THE LLANELLY BOILER EXPLOSION.—In the report of the officers of the Railway Department of the Board of Trade, just published, the explosion (29th January, 1858) of the boiler of a locomotive on the Llanelly line is attributed to the "worn-out state of the machine," and not to any undue pressure of steam; the old plate on the top of the boiler having been reduced in thickness from 7-16ths to 5-16ths of an inch, and in one spot, close to the steam-dome, it was only 4-16ths of an inch thick.

A "STEAM-BOILER ASSURANCE COMPANY" has been established at Manchester. It was first suggested by the late Mr. Thomas Forsyth, one of the victims in the recent catastrophe at the Atlas Works. It is computed that within a radius of 10 miles round Manchester there are more than 50,000 boilers, giving a total of 1,250,000 H.P.

MINES, METALLURGY, &c.

CRISIS OF THE IRON TRADE IN FRANCE.—According to the French papers, "the very existence of the iron trade in France is at stake." "Several of the ironmasters have closed their establishments—many others have slackened work, and discharged their workmen, having left on their hands nearly the whole of the bars, castings, &c., produced for the last six months."

A MINERALOGICAL DISCOVERY of some importance—namely, of a rich deposit of IRON ORE—has very recently been made by the mining engineer of Valenciennes, in the Northern Department, France. The ore, which is stated to be of first-rate quality, is siliceous, intimately blended with magnesian limestone (a flux, by the way), and disseminated through an argilaceous mass, of which it forms about one-half. It belongs to the class of *yellow ores*, the exportation of which, from Belgium into France, is strictly prohibited by the Belgian Government.

NOVA SCOTIA—GENERAL MINING ASSOCIATION.—The last report announces the definitive purchase by this Company of the interest of the late Duke of York in the mines of Nova Scotia, granted by the Crown, and the grant of a new lease from the Provincial Government.

THE NEWLY-DISCOVERED "COUTEAU GOLD MINES," so called from the name of a tribe of Indians in their vicinity, are now attracting legislative attention to our hitherto but scarcely noticed possessions—the north-west territories of British India. A mining duty of 20s., imposed by Governor Douglas, of Vaucouver's Island, has been resisted by a party of American adventurers and others. Frazer's River has been blockaded by the English Local Government, and a supply of troops requested from home.

RELATIVE COST OF FUEL (FOR IRONWORKS) IN FRANCE AND ENGLAND.—The "Moniteur Industriel" states that *one ton of charcoal* (the fuel chiefly used in the French furnaces) bears a higher price, even in the most favored parts of the Empire, than does *one ton of cast iron* in England; and that the average consumption in the French furnaces is one ton of vegetable fuel for every ton of melted iron.

ALUMINIUM.—A new alloy, under the name of "bronze aluminium," has been invented by M. Delanone, of Valenciennes. It consists of one-tenth aluminium and nine-tenths copper: has the appearance of pure gold—is remarkably easy to cast and chisel; and is much less subject to oxidation, discolouration, &c., than the ordinary bronzes or brass castings. It is suggested that this bronze, which is very hard, might be advantageously used for the bearings of machinery.

GOLD FROM NEW ZEALAND.—The vessel *Duchess of Leinster* has arrived from Nelson, New Zealand, at Melbourne, with 2,500 ounces of gold, consigned to the Union Bank of Australia. "This," adds the 'Australian and New Zealand Gazette,' "is the first shipment of the newly discovered gold-fields in that colony on any large scale."

Government School of Mines (Jermyn-street).—By the House of Commons a return has been ordered of all students for the session 1857-8 who have attended these lectures, and also who have passed the examinations of the school, from its establishment to the present time, with specification of their present engagements.

Submarine Mines (Cornwall).—The dispute relative to the respective rights of the Crown and Lessees to the produce of mines driven under the soil lying between high and low water-mark has been finally adjusted, on the basis of the Crown receiving one-fifteenth. In the House of Commons (July 9th), the Chancellor of the Exchequer introduced a Bill to declare and define the respective rights of Her Majesty and the Prince of Wales, and the Duke of Cornwall, to the mines and minerals in or under land lying below high-water mark, within and adjacent to the county of Cornwall.

A New Gold Field in Australia has been opened at the head of the Murray River upon the New South Wales side (Moreka Creck), above Jingellic, 90 miles from Albury. The gold is represented as being found a few feet from the surface, and very pure.

Coal for the Woolwich and Portsmouth Dockyards.—On the 9th July, a return was published of all coals tried at these dockyards, specifying the description, the evaporative power, the amount of ash, clinker, and smoke, &c. The return was moved by Mr. Liddell, M.P. The details are given at great length, but there is no formal report on the merits of the different coals.

A Fatal Colliery Accident, by which three men were killed and four others severely injured, occurred on the 10th July ult. at the "Middle Duffryn Set," in the steam coal mining district of Mountain Ash, near Aberdare. The men were being lowered in a basket, which came in violent contact with the guide-chain, and the hauling-chain being broken by the collision, the bucket was precipitated down the shaft. The mine is one of the chain of collieries from which the famous "Duffryn steam-coal," extensively used in the Navy and in the public mail-services, is raised.

Locality of the New Gold Field on Frazer's River.—The precise *locale* of the modern "El Dorado" is thus given in the "New York Times:"—"Frazer's River empties into the Gulf of Georgia, a branch of Puget's Sound, a few miles north of the 49th parallel, which is the boundary between America and the British possessions. Its head-waters interlock with those of the Columbia and the Athabasca. At the distance of 160 miles from its mouth it is joined by Thompson's River. At the junction of the two rivers, and in the immediate vicinity, lie the 'diggings' which are causing so much excitement on the Pacific Coast. They have been worked more or less since last summer, but their real importance was not ascertained until lately. The whole distance from the mouth of Frazer's River to the gold diggings at Thompson's River is 160 miles, or thereabouts. The latitude of the Thompson's River Forks is about 50° 30′, *or nearly* 300 *miles further north than Quebec.*" The Frazer's River Mines, therefore, are not easy of access.

The Inspectorship of Coal Mines for Monmouth, Gloucester, and Somerset, has become vacant by the death of Mr. Herbert Francis Mackworth.

Practical Mining.—Improvements in Boring.—A saving in the time consumed in driving levels and in tunnelling has been effected by Messrs. Sommeiller, Grattone, and Grandis, three Sardinian engineers, engaged in making the great tunnel through the Alps from Modana to Bardonnèche. The crest of the mountain through which the tunnel is to pass being about 1 mile above the level of the tunnel, the ordinary mode of sinking shafts and commencing from several points simultaneously was out of the question, and as the tunnel could not be worked from the two extremities, it was calculated that it would require thirty-six years to complete it. By a new system of perforation and ventilation, and by availing themselves of the abundance of water which exists in the locality, these difficulties have been overcome. Their invention consists of an hydraulic air-condenser and a perforating instrument. The condenser is a syphon turned with its orifices upwards, one of which is in communication with a stream of water, and the other with a reservoir of air. The water passes down the first branch, enters the second, and by its pressure condenses the air, which is then forced into the reservoir. By the opening of a valve the water in the syphon is let out, and the operation recommences. The induction and eduction valves are worked by a small machine, operating by the force of a column of water communicating with another reservoir above. A fall of about 24 ft. is sufficient to condense the air to six atmospheres, which is equal to a pressure of nearly 70 ft. of water. The condensed air is used first as a motive power, and then for ventilation. As a motive power it is used to work the perforators, and the mode by which these little machines are worked affords a proof of the possibility of employing compressed air for that purpose with advantage. By this means, blasts may be bored through the hardest syenite in one-twelfth the time usually taken. Eighteen perforators may be set to work where there would scarcely be sufficient room for six miners. By the aid of these contrivances, combined with machinery to remove the rubbish, the completion of the undertaking will, it is estimated, be reduced from thirty-six to six years. The rate at which the work is progressing is at present about 6½ ft. in the twenty-four hours, *i.e.*, 3 ft. 3 in. at each side of the mountain.

Mining a Profitable Investment as Compared with Banks and Railways.—The "Mining Journal" maintains, as being clearly proved by calculations, showing the results of an investment, twelve months ago, in eight of the best railways, eight of the best banks, and eight of the best mines, that the mines pay *more than double* the rate of interest of either banks or railways, and that shares yield a handsome profit on the outlay in addition.

Mining in Algeria.—The ore produces not only the best grey pig iron, but crude steel (*spiegel eisen*) at pleasure, and yields in the furnace 66 per cent. of metal. It is shipped in considerable quantities to France, where it is smelted with coke near Marseilles, and with charcoal in about thirty Catalan furnaces near the Pyrenees, being sent by rail from the sea to Toulouse. Near Bôna, in Algeria, it is also smelted by a Parisian company, who have there two well-conducted blast furnaces, one of which only is in blast at the present time, using charcoal brought from Corsica, producing with cold blast 70 tons of crude steel weekly, which is sent to Marseilles, where it is sold at upwards of £9 per ton. The peculiarity of the pig iron is its ductility and strength. The mines, or rather open quarries, are situated at Karezas, about 7 miles inland from Bôna; they are connected with the Seybonse River by a railway, on which the first locomotive was started last month; another is nearly ready for shipment. The ore is loaded in lighters, and conveyed to vessels at anchor in the roadstead of Bôna.

Puddled Steel.—From the "Mining Journal" it appears that it is the opinion of practical men, that it will no longer be necessary to allow Prussia and Belgium to take the lead of this country in the production of puddled steel, as the ore from the Mokta-el-Hadid (the iron-quarry), a few miles distance from Bona, in Algeria, can be brought here and to Wales in large quantities, and at a price that will compete successfully with the ores at present in use: whilst from its superior quality, and the fact that *crude steel* is made from it, the importation cannot fail to be of great importance. This iron quarry, formerly worked by the Romans, is a mountain of iron-ore, calculated to contain in one compact mass not less than 125,000,000 tons above the level of the plain. It is, in fact, one mass of ore, apparently all of the same quality, showing to view a face of several hundred yards in extent, and about 400 ft. high. Analysis—Peroxide of iron, 66·00; protoxide, 22·00; carbonate of lime, 2·20; ditto magnesia, 0·2; silica, 0·2; alumina, 0·6; water, 1·8 = 100.

Iron Cottages for Workmen.—Sir Francis C. Knowles, the proprietor of the Wardsend Steel Works, is having erected, at Wardsend, several ranges of iron buildings for the accommodation of his workmen—fifty cottages for the married men and their families, and a lodging house for the single men, containing twenty apartments, with kitchen, private rooms, day rooms, and lavatories. A school-room is also being provided for the children of the workmen. The whole are to be warmed and lighted with gas, and are to be erected of corrugated iron.

APPLIED CHEMISTRY, &c.

Effluvia Test.—Mr. Maugham, chemist to Charing-cross Hospital, in his recent evidence (18th July) before the Thames Parliamentary Committee, says, "Part of Mr. Gurney's scheme is to *burn the noxious gases arising from the sewage.* I yesterday tested the air of the sewers: previously to burning the gases, I placed a slip of paper which had been subjected to a chemical process in the sewer-shaft, which clearly showed the presence of *sulphuretted hydrogen* by colouring the paper. After the gas had been burnt, according to Mr. Gurney's plan, I placed a piece of paper similarly prepared, and the result was that the paper came out *perfectly white.*

Copper and Silver in Sea-Water.—M. Septimus Piesse has recently proved the existence in sea-water of copper, in sufficient quantity for him to affirm that the intense blue of certain seas is due to the presence of a compound of ammonia and copper; and the green colour of other seas to the presence of chloride of copper. He had suspended to the sides of a steamboat, crossing between Marseilles and Corsica and Sardinia, a bag filled with iron nails and turnings; and after a few journeys a notable quantity of copper had been deposited on the surface of the iron. We know that by analogous means (by the suspension in sea-water of grain-copper), Messrs. Durocher and Malaguti had proved the existence in sea-water of an appreciable quantity of silver. M. de Sussex has indicated that when, in the preparation of glass, he melts in his crucible the sand of the river Seine, taken below Meudon, after polishing the inner surface of the bottoms of the broken crucibles, one may distinctly perceive, not only specks, but *small pellets* of gold.

Deodorising Processes.—Dr. Hoffman, in a communication recently read before the Metropolitan Board of Works, states that the several deodorising processes by lime, Stothert and Gotto's mixtures, filtration through charcoal, shaking with charcoal, &c., are all of them partially good; but at the same time it is found that these several processes leave a large quantity of putrescible organic matter in solution, which, especially in hot weather, is apt to undergo decomposition and to generate effluvia of the most offensive and dangerous character.

The New Metal "Aluminium."—This novel product of the science of electro-metallurgy, as yet but imperfectly known and adopted in this country, appears to be making its way steadily in France. The Industrial Society of Mulhouse, in their recent sitting (30th June ult.), presented to their president, M. Emile Dollfus, as a testimonial, in recognition of his long and distinguished services, an *aluminium cup*, richly chased, and bearing various inscriptions in gold letters, commemorative of their sense of his exertions in the cause of industrial science.

Indigo Purple for Dyeing.—According to the *Schweizerische Polytechnische Zeitschrift* (Swiss Polytechnic Journal), M. Mühlberg, of Aarau, has discovered and published a new method of treating indigo, in order to extract a fine purple equal, in all respects, to the indigo purple of the Brothers Knesp, of Kuttgard, the only preparation of its kind hitherto used in the trade, and the secret of which has been closely kept. He recommends one part indigo, in fine powder, to be reduced to a paste by the addition, drop by drop, of twenty parts of common sulphuric acid, at 66°, whilst at the same time, by means of refrigerating arrangements, externally applied, the temperature is to be as much as possible prevented from rising too high in the vessel containing the mixture. The acid is left to act for some time on the indigo. In about half an hour a very deep violet red is produced. The whole of the mass, reduced to a clear paste, is then to be poured into a large quantity of water, and left to subside; or it may be filtered immediately after it has cooled down. The filtered liquid which contains sulphate of indigo is blue, whilst according to the duration of the chemical action, and the quantity of sulphuric acid, the sediment or precipitate is of a fine violet colour, tinged more or less with red. It is then to be well washed, first in water, and afterwards with a very dilute solution of carbonate of soda, until no further acid reaction is perceivable. The liquor which has passed through the filter may be used either as a bath for dipping wool, or the colouring matter may be extracted by adding a solution of soda, the product being an indigo-carmine. The product remaining in the filter possesses all the qualities of the famed Wurtemberg indigo-purple.

Manufacture of Sulphurous Acid.—Improvements in the economic production of sulphurous acid, by treating pyrites and sulphates, sulphides and sulphites, and hyposulphites of various kinds, in a suitable furnace, have been patented by Mr. G. Townsend, of Glasgow. The furnace is first heated with coal—a layer of pyrites is placed on the fire, and then a layer of the sulphate, sulphide, sulphite, or hyposulphite. The pyrites keep up the heat, and sulphurous acid is distilled over most effectually.

The Electro-Deposition System for Plated Articles, &c.—A very large expansion of the manufacture of plated articles at Birmingham has followed the adoption of the electro-deposition process, in preference to the old system of manufacture, wherein the base of all plated articles was copper, plated with silver, the adhesion of the silver being effected by soldering together a thickness of copper and silver, and then passing the same through rolls until the necessary thickness was arrived at, the copper and silver elongating together. Amongst the various disadvantages arising from this mode of production, a signal one was, that the ornamental mouldings, stamped out of thin silver and filled with lead, speedily became, by cleansing, so thin that the filling showed through. In the new system the article may be silvered in a complete state - every portion may be soldered together with hard solder, and owing to the tendency of the deposited metal to attach itself to all the points and angles, the coating is really thickest where it is necessary for wear that it should be.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 4th March, 1858.

430. W. Wilkinson, Bayswater—Apparatuses for spinning threads, for preparing threads, for weaving and knitting, for covering cores with fibrous and other materials.

Dated 6th March, 1858.

460. P. A. Cap, Paris—Billiard table for drawing-rooms.

Dated 10th April, 1858.

776. J. Oxley, Beverley, Yorkshire—Doors and sashes of carriages.

Dated 7th May, 1858.

1022. W. Duff and J. Gilchrist, Liverpool—Apparatus for measuring water and other fluids.

Dated 19th May, 1858.

1112. H. Walker, Gresham-street—Needles.

Dated 21st May, 1858.

1138. W. Clark, 53, Chancery-lane—Processes of treatment of peat, and of the hydro-carburets it contains.

Dated 25th May, 1858.

1168. P. Griffiths, Manchester-road, Burnley, Lancashire—Manufacturing bushes for fixing drums on shafts.

Dated 26th May, 1858.
1178. J. Luis, 1B, Welbeck-street, Cavendish-square—Apparatus for cutting square-headed corks, and for corking bottles with the same.
Dated 27th May, 1858.
1192. W. Clark, 53, Chancery-lane—Preserving butter.
Dated 29th May, 1858.
1208. J. Shuttleworth, Stamp End Works, Lincoln—Portable and other steam-engine boilers.
1210. W. Hodgson and H. Hodgson, Thornton-road, Bradford—Apparatus for preparing and spinning, or producing motley yarns from rovings of unequal thicknesses of wood.
1212. S. Rockett and J. J. Reynolds, Strand—Umbrellas and parasols.
1214. T. V. Lee, Thames-chambers, York-buildings, Adelphi—Steam generators applicable to marine locomotive.
1216. D. Hebson, Liverpool—Ships' gear.
1217. M. Henry, 84, Fleet-st.—Preparing agents for dyeing, preparing for dyeing and tanning, and applying certain of the resulting products for obtaining pulp for paper and pasteboard.
1218. J. Schloss, 75, Cannon-st. west, City—Book-clasp, or improved fastening of books.
Dated 31st May, 1858.
1219. J. Young and J. Strang, Castle Glen and Glasgow—Manufacture of starch, gum, or dextrine, and their compounds.
1220. J. B. Thornder, Halifax—Carriages for children commonly called "perambulators."
1221. J. B. Girerd, 36, Newman-st., Oxford-st., and F. L. Wohlgemuth, 57, New Bond-st., Hanover-sq.—Ornamental staining, dyeing, and fixing designs, writing, letter-press and type printing and ciphering, and colours.
1222. G. K. Snow, Watertown, Massachusetts, U.S.—Machine for affixing postage stamps to letters.
1223. W. Parsons, Pratt-st., Old Lambeth—Steam engines for propelling vessels and other purposes, and in bearings for the screw shafts of steam vessels.
1224. H. Jaeger, Paris—Dyeing wool.
1225. W. E. Newton, 66, Chancery-lane—Printing and dyeing textile and other fabrics.
1226. J. Austin and J. Armstrong, Wellington, Salop—Manufacture of coke.
Dated 1st June, 1858.
1227. C. Binks, London—Manufacturing soap.
1228. A. Barchou, 22, Cranbourn-st., Leicester-sq.—A heel for boots and shoes.
1229. C. F. Vasserot, 45, Essex-st., Strand—A kind of tramway to facilitate the locomotion of bedsteads.
1230. A. G. Grant, New York—Preparing paper in order to render it waterproof.
1231. A. G. Grant, New York—Stand for cameras, theodolites, guns, and other articles.
1232. R. W. Chandler, Bow, and T. Oliver, Hatfield, Hertfordshire—Agricultural apparatuses for ploughing.
1233. J. Lang, Calder-vale, Garstang, Lancashire.—Method of signalling on railways.
Dated 2nd June, 1858.
1234. F. J. Candy, Haslemere, Surrey—Machinery for the manufacture of fishing and other nets.
1235. J. Mannhardt, Munich—Machinery for the manufacturing of peat fit for fuel, and for the squeezing or forcing of fluids out of the said turf, peat, or similar substances.
1236. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A new farming implement called the gleaner.
1237. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A new description of plough, with fore-carriage applicable to all swing or common ploughs.
1238. D. Service, Barrhead, Renfrew, N.B.—Apparatus for producing printing surfaces.
1239. C. Wheatstone, Hammersmith—Electro-magnetic telegraphs.
1240. H. Brown, B. Hodgson, and J. Carter, Halifax.—Machinery for introducing and withdrawing wires when weaving.
1241. C. Wheatstone, Hammersmith—Electro-magnetic telegraphs.
1242. R. Roberts and W. Shaw, Heaton Norris, Lancashire—Looms for weaving.
1243. J. E. F. Luedeke, Marke, Hanover—Motive power engines.
Dated 3rd June, 1858.
1244. J. Meiklejon, Dalkeith, N.B.—Boilers for heating water, and in valves for controlling and regulating the flow or passage of the same.
1245. R. Owen, Manchester—Water-closets, night commodes, and similar conveniences.
1246. W. Clayton and J. Goodfellow, Blackburn—Pistons for pumps.
1247. J. Bethell, 8, Parliament-st., Westminster—Manufacture of alum.
1248. T. Scholefield, Paris—Gas meters.
1249. A. V. Newton, 66, Chancery-lane—Manufacture of woven fabrics.
1250. G. Dalton, Lymington—Furnaces for smelting the ores of iron.
1251. J. Mitchell, Dunning's-alley, Bishopsgate-street-without—Purifying paraffine.
1252. R. Owen, Rotherham, Yorkshire—Manufacture of railway wheel tires.
1253. H. Edwards, Dalston—Pipe stem or tube.
1254. T. Wilson, Bradmore House, Chiswick—Construction of mangles.
1255. J. Baron Von Liebig, Munich—Protecting the silvered surface of mirrors and other articles of glass.
Dated 4th June, 1858.
1256. W. Hargreaves and E. Haley, Bradford—Apparatus for preparing and combing wool, hair, silk, cotton, and flax.
1257. E. M. Stoehr, Manchester—Looms for weaving.
1258. J. F. Dickson, 6, Russell-st., Litchurch, near Derby—Permanent way of railways.
1259. V. Merighi, Paris—Preventing dust on railroads.
1260. V. Merighi, Paris—Impeding and exhausting fires on railway trains.
1261. T. Crick and J. T. Crick, Leicester—Manufacture of boots, shoes and slippers.
1262. R. Quin, 5, Rodney-st., Pentonville—Ordnance and fire-arms.
1263. R. A. Brooman, 166, Fleet-st.—Preparing the fibrous portions of certain textile plants, and their employment when prepared either along or in combination with articles already in use, for the purpose of stuffing.
Dated 5th June, 1858.
1265. J. Banks, Liverpool—Reaping machines.
1266. M. Page, Valdoie, near Belfort, Paris—Power kneading apparatus.
1267. H. Carter, Manchester—Gas burner.
1268. C. Hancock, West Ham Gutta Percha Company, West-st., Smithfield—Manufacture of electric telegraph cables.
1269. E. Cooke and G. Dickinson, Smethwick, Staffordshire—Manufacture of metallic and other bedsteads.
1270. R. Orr, Glasgow—Apparatus to be applied to various machines used in the manufacture of yarn or thread.
1271. A. Manbré, Rathbone-place—Method of preparing malt and other grain, and in preparing the saccharine matter therefrom.
1272. F. H. Whiteman, 28, Essex-st., Islington—Rendering paperhangings, for decorating the interior of houses, capable of being washed by soap and water.
1273. W. Porter, 9, Lansdown-villas, Brompton—Artillery ordnance and other descriptions of fire-arms.
1275. G. Hadfield, Carlisle—Protection of carboys or other vessels and packages.
Dated 7th June, 1858.
1276. E. Scotson, Clayton, and H. Charley, Grimshaw-st., Foundry, Preston, Lancashire—Machinery connected with traction and other engines.
1277. J. Ferrabee, Thrupp, near Stroud—Machinery for cutting, collecting, and spreading grass.
1278. J. J. Rowley, Rawthorne, near Chesterfield—Apparatus for applying lime, soot, and other matters, to turnips and other crops.
1279. J. Boullenger, and L. J. Martin, Paris—An apparatus serving to the decomposing neutral fatty substances into fatty or oily acid and glycerine.
1280. J. M. Dunlop, Manchester—Apparatus for sizing fibrous materials.
1281. H. Wimball, Aldermaston, Berkshire—Apparatus for destroying the turnip fly and other destructive insects on growing crops.
1282. E. Vigers, Paddington—Manufacture of bricks.
1283. J. B. A. Lombard and X. T. Esquiron, Paris—Improved method of obtaining saccharine substances from cereal and vegetable matters.
1284. R. Hicks, Chatham-pl.—Manufacture of compositions to be employed as black lead.
Dated 8th June, 1858.
1285. J. M. Dunlop, Manchester—Bowls or rollers used in machines for printing fibrous materials.
1286. R. Wappenstein, Manchester—Artificial whalebone, applicable to umbrellas, parasols, and stays.
1287. I. Ketchum, 59, Canning-st., Liverpool—Self-acting perforated baster.
1288. J. C. Quince, Crosby-hall Chambers, Bishopsgate—Stoppers for bottles and jars.
1289. R. A. Brooman, 166, Fleet-street—Manufacture of copper pipes and tubes.
1290. W. Clark, 53, Chancery-la.—Preparation of extract of Peruvian guano.
1291. A. Robertson, Sheffield—Stoves or fire-grates.
1292. J. Bunnett, Deptford—Construction of floors, roofs, and arches.
1293. D. Irons, 6, Cornwall-ter., Creek-road, Deptford—Mariners' compass.
1294. J. Rawlings, Collingbourn Ducis, Wiltshire—Thrashing machines.
1295. A. Rigg, sen., and A. Rigg, jun., Chester—Apparatus for tipping or upsetting coals, minerals, or other substances, and in brake machinery.
Dated 9th June, 1858.
1296. G. Suares, 1, Cullum-st., Fenchurch-st.—Fire-arms.
1297. F. A. Gatty, Accrington—Dyeing cotton and other fibrous materials and fabrics.
1298. D. Moseley, Chapel Field Works, Ardwick—Vulcanized india-rubber thread.
1299. S. Lees, Salford—Manufacture of tan or tanning.
1300. E. T. Hughes, 123, Chancery-lane—Apparatus for sowing grain.
1301. E. C. Grimshaw, Denton, Lancashire—Furnaces and steam boilers.
1302. W. A. Gilbee, 4, South-st., Finsbury.—Railway wheels.
1303. C. F. Vasserot, 45, Essex-st., Strand—An apparatus for measuring and registering the flow of liquids.
1304. J. Easterbrook, Sheffield—Ratchet braces.
1305. P. Dumont, Southwark-sq., Borough—Improved implements for distributing or applying powder.
1306. T. W. G. Treeby, 1, Westbourne-terrace-villas, Upper Westbourne-terrace, Paddington—Revolving fire-arms, cannon, and cartridges.
1307. H. Rollinson, Stepney—Artificial fuel.
1308. T. Robinson and H. Ogden, Manchester—Safety lamps.
1309. J. Roberts, Upnor, Kent—Construction of reflector or cover for gas burners.
1310. C. Cammell, Cyclops Steel Works, Sheffield—Railway buffers.
1311. J. Roberts, Upnor, Kent—Stove.
Dated 10th June, 1858.
1312. G. Castle, 10, Tamworth-road, Croydon—Ventilating women's stays by means of perforation.
1313. T. W. Mellor and W. Jamieson, Ashton-under-Lyne—Looms for weaving figured fabrics.
1314. J. Luis, 1B, Welbeck-street, Cavendish-square—An alembic wine examiner.
1315. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Thrashing machine.
1316. J. Luis, 1B, Welbeck-street, Cavendish-square—Balance beam thrashing machine.
1317. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Nose-bag for giving horses their oats, &c.
1318. T. Chatwin and C. Taylor, Birmingham—Screw stocks.
1319. J. S. Crosland, Ashton-under-Lyne—Steam engines.
1320. W. Davis, Loveday-st., Birmingham—Certain imp. in the tangs of awls; also in the mode of manufacturing awl-blades.
1321. G. Hall, St. John's, Worcester—Cartridges.
1322. H. Reynolds, King William-street—Method of separating glycerine from saline.
1323. W. Wilkinson, Bayswater—Certain new textile and other combined fabrics, and means of ornamenting fabrics and skins.
1324. W. C. Wilkins, Long-acre—Lighthouses.
Dated 11th June, 1858.
1325. J. Gemmell, Belfast—Starch.
1327. L. A. Bigelow, 133, High Holborn—Machine for sweeping carpeted and other floors.
1328. G. Bartholomew, Linlithgow, N.B.—Gas meters commonly called wet meters.
1329. W. E. Newton, 66, Chancery-lane—Apparatus for supplying boilers with water.
1330. S. Cheavin, Spalding—Combination of mineral substances, applicable for use as a pigment, cement, or mastic.
1331. L. F. Lenière, Canderan, France—Treating hemp or tow for the caulking of ships or vessels.
1332. G. W. Hart, 5, Osborn-terrace, Southsea—Locks.
Dated 12th June, 1858.
1334. G. T. Stieler, Manchester—Generating steam and economising fuel.
1335. J. Hull, Derby—Slide valves of steam engines.
1336. W. Clark, 53, Chancery-lane—Machinery for combing cotton and other fibrous material.
1337. A. Gibson, J. Pollock, and J. Martin, Stratford—Construction of steam engine boilers and furnaces for effecting the prevention of smoke.
1338. W. Clark, 53, Chancery-la.—Preparation of a vegetable product, and its application as a fibrous or textile material.
1339. A. V. Newton, 66, Chancery-lane—Machinery for cutting veneers.
Dated 14th June, 1858.
1340. W. Clark, 53, Chancery-lane—Curtain poles or rods.
1341. J. H. Young, 66, Great College-st., Camden-town—Setting up (composing) and distributing types.
1342. H. J. Daniell, Donington-park, Derbyshire—A process by which the stamp on banker's checks is cancelled, and the check indelibly and simultaneously crossed.
1343. H. N. S. Shrapnel, Medway Manor House, Bradford—Preparing iron and other metals, or mixtures of metals, for and in casting the same in moulds.
1344. G. Neall, Northampton—Gas stoves for warming, cooking, and other purposes.
1345. J. Hetherington, Store-st. Mills, Manchester—Guides or clearers used in machines for winding, reeling, and clearing threads of cotton, silk, and other fibrous materials.
1346. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for breaking or crushing stones for road metal.
1347. J. C. Henderson, Albany (U.S.)—Stoves.
Dated 15th June, 1858.
1349. L. C. S. Masson and F. De la Moriniere, Paris—Manufacture of woven fabrics with coloured patterns.
1350. B. Pitt, 4, Great Carter-lane, Doctor's-commons—Construction of knobs and roses used with locks and latches.
1351. G. Adshead, Staley New Mills, Staleybridge, Chester—Steam boilers.
1352. Baron F. Julius, Wedel-Jarlsberg, Frederikswoern, Norway—Self-registering compass or control compass.
1353. W. P. Wilkins, Ipswich—Arrangements and construction of refrigerating apparatus.
1354. Sir F. C. Knowles, Bart., Lovel-hill, Berkshire—Manufacture of steel.
1355. H. S. Warner, Trinidad—Manufacture of decolorizing and purifying charcoal.
1356. A. Dembinsky, Islington, and A. O. Engert, City road—Fire-proof composition or wash.

1357. J. Rubery and T. Warwick, Birmingham—Machinery and tools for making certain portions of umbrellas and parasols and lingoes.

Dated 16th June, 1858.

1358. B. Predavalle, 470, New Oxford-st., Bloomsbury—Mode of obtaining motive power.
1359. G. T. Bousfield, Loughborough-park, Brixton—Apparatus to be used in the construction of small boats.
1361. C. W. Lancaster, New Bond-st.—An instrument for charging cartridges for breech-loading arms.
1362. W. Sawney, Beverley—Apparatus applicable to screening, winnowing and corn-dressing machines.
1363. J. J. Creegen, Plough-road, Rotherhithe—Treatment of India and China grass, pine apple, hemp, flax, and other similar fibrous materials.
1364. J. H. Dickson, Stanley-terrace, Rotherhithe—Apparatus for scutching and hackling flax and hemp.
1365. J. C. Hill, Wildon Iron Works, near Abergavenny, Monmouthshire—Apparatus for ascertaining and indicating the height of water in steam boilers.
1366. J. Westwood, London-yard, Isle of Dogs, Poplar—Construction of iron ships.
1367. G. Davies, 1, Serle-st., Lincoln's-inn—Equilibrium slide valve for steam engines.
1368. T. Steven, Glasgow—Moulds for casting.

Dated 17th June, 1858.

1369. J. H. Marsden, Manchester—Hats.
1370. F. Walton, Wolverhampton—Manufacture of japanned wares.
1371. J. Haslam, Preston—Looms for weaving.
1372. J. Allardice, Glasgow, and W. Miller, Blantyre, Lanark, N.B.—Gasaliers.
1373. A. Dawson, 14, Barnes-place, Mile End-road—Apparatus for converting small coals or coal-dust, or small coals and coke, with the admixture of water, into artificial fuel.
1374. G. Hale, Tavistock-st., Covent-garden—Apparatus for obtaining motive power.
1375. S. Taylor and D. Taylor, Rochdale—Apparatus for putting machine straps or belts on to pulleys or drums, and for removing the same.
1376. C. Crockford, Holywell, Flintshire—Treatment of the ores of zinc.

Dated 18th June, 1858.

1377. W. Blizzard, 14, Victoria-ter., Ladbroke-rd., Notting-hill—India-rubber and gutta percha.
1378. J. Shaw, Cheapside, Leicester—Fire-arms.
1379. R. S. Newall, Gateshead—Cords, ropes, and cables.
1380. W. Spence, 50, Chancery-lane—Clogs, shoes, or supports for the feet.
1381. P. B. E. Martin, Paris—Obtaining electro-motive power.

Dated 19th June, 1858.

1382. F. G. Spilsbury, Dresden, Saxony—Making tungstic acid and certain of its salts, and for using the same to decolour acetic acid and its compounds.
1383. S. Hewitt, Manchester—Application of printed designs to cotton and other fabrics.
1385. J. Bradshaw, Bolton-le-Moors—Obtaining and producing motive power.
1386. R. Winans and T. Winans, Baltimore, U.S.—Imp. in the form of the hulls of steam vessels.
1387. R. Winans and T. Winans, Baltimore, U.S.—Steam vessel.
1388. R. Winans and T. Winans, Baltimore, U.S.—Imp. in ocean steamers.
1389. R. Winans and T. Winans, Baltimore, U.S.—Mode of combining the engines and propeller shafts of steam vessels.
1390. R. Halldon, Willenhall, Staffordshire — Engines worked by steam or atmospheric power.
1391. H. Becu, Merville, France—Manufacture of lathes, and in fixing and nailing the same.

Dated 21st June, 1858.

1392. Sir J. C. Anderson, Bart., Fermoy—Locomotion.
1393. H. H. Henson, 38, Parliament-st.—Waterproofing ropes, strands, cordage, and cables.
1394. R. A. Brooman, 166, Fleet-st.—Steam-cocks.
1395. R. A. Brooman, 166, Fleet-st.—Treating wood to preserve and colour it.
1396. J. Lawder, Lieut. and Brevet Capt. in the Honourable the East India Company's Army—Carrying knapsacks, packs, and other weights on the back.
1397. J. Crossley, St. Helen's, Lancashire—Machinery for grinding, smoothing, and polishing glass.
1398. W. C. Wilkins, Long-acre—Lamps.
1399. W. Thrift and A. High, Bedford-st., Commercial-rd. east—House water-closets.
1400. W. E. Newton, 66, Chancery-lane—Method of effecting the separation of the fibres of wood for the manufacture of paper therefrom.
1401. A. V. Newton, 66, Chancery-lane—Manufacture of spoons and forks.
1402. W. E. Newton, 66, Chancery-lane—Machinery for obtaining from waste and refuse felted fabrics of wool, fur, or other materials, fibres in a suitable condition for being worked into felt and other fabrics.
1403. G. R. Scriven, Philadelphia, U.S.—Apparatus for ventilating, and for circulating and moving air or other fluids.
1404. H. Deacon, Widnes Dock, near Warrington, Lancashire—Purifying alkaline lees.

Dated 22nd June, 1858.

1405. M. Mayall and G. Jackson, Mosley, Lancashire—Apparatus for spinning cotton and other fibrous substances.
1406. G. Schaub, Birmingham—Manufacture of door plates, sign-boards, and other surfaces, having inscriptions, designs, or ornaments thereon.
1407. W. Galloway and J. Galloway, Manchester—Machinery for cutting, bruising, chipping, and rasping or preparing dye woods and roots.
1408. J. Pym, Trinity-sq., Surrey—Machinery for felling trees.
1409. J. A. Rainé, 16, Wells-st., Gray's-inn-road—Collapsible framework for bedsteads, sofas, &c.
1410. W. E. Kenworthy, Water-lane, Leeds—Manufacture of steel.
1411. P. Brown and B. Young, Spa-road, Bermondsey—Manufacture of white lead.
1412. E. Cockey, H. Cockey, and F. C. Cockey, Frome, Somerset—Apparatus employed in the manufacture of cheese.
1413. J. Robertson, Glasgow—Apparatus for regulating the flow or passage of fluids.

Dated 23rd June, 1858.

1414. S. Barlow, Stakehill, near Middleton, Lancashire—Apparatus for bleaching or cleansing textile fabrics or materials.
1415. T. Spencer, 192, Euston-road, Euston-sq.—Treatment of iron ores and ferruginous sands.
1416. C. Vero and James Everitt, Atherstone, Warwickshire—Hats.
1417. P. J. Livsey, Manchester, and F. L. Stott, Rochdale—Machinery for warping yarns or threads.
1418. W. Clibran and J. Clibran, Manchester—Arrangements for distributing, governing the pressure of, and lighting gas.
1419. R. Armstrong, North Woolwich—Steam boilers and furnaces.
1420. Sir J. Paxton, M.P., Rock-hill, Sydenham—Manufacture of horticultural buildings, or glazed structures for horticultural and other purposes.
1421. R. Rumney, J. Mellor, and W. S. Macdonald, Manchester—Dyeing and printing cotton, wool, silk, &c.
1422. W. E. Newton, 66, Chancery-lane—Centrifugal governors for steam engines and other motors.

Dated 24th June, 1858.

1423. C. Bordas, 8, Upper Stamford-st., Blackfriars-road—Method of producing embroidery.
1424. J. Bates and J. York, Hyde, Chester, and W. Parkin, Sheffield—Pistons and plungers.
1425. P. Griffiths, Manchester-rd., Burnley, Lancashire—Shaft couplings.
1426. G. Collier, Halifax—Apparatus for the stretching and drying of woven fabrics.
1427. J. Robinson, East India-rd.—Adapting water-closets to ships.
1428. W. E. Newton, 66, Chancery-lane—Machinery for manufacturing friction matches.
1429. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for making bolts and rivets.
1430. B. Pickering, Lockerbie, Dumfries, N.B.—Communicating signals from one part of a railway train to another.

Dated 25th June, 1858.

1432. J. Betts, Strand—Surfaces on which to print maps and other designs.
1433. C. Nightingale, Wardour-street, Soho—Apparatus applicable to curling and spinning machines for horse hair.
1434. T. Booth, Rahere-st., Goswell-road—Mounting and fitting wheels and axles to carriages.
1435. R. Smith, 45, Essex-street, Strand—Fire-arms and ordnance.
1436. J. Maudslay, Lambeth—Construction of furnaces for melting iron, steel, and other metals.
1437. J. Westwood, London-yard, Isle of Dogs, Poplar—Plating of ships and floating and other batteries, to render the same shotproof.
1438. J. Taylor, Swanton Novers, Thetford, Norfolk—Horse hoes.

Dated 26th June, 1858.

1439. P. M. Crane, Irish Peat Company's Works, Athy, Ireland—Manufacture of fuel from peat.
1441. W. L. Tizard, Mark-la.—Method of treating brewers' and distillers' malt or grist.
1442. S. Whitchall, Jacquard works, Huskinson-st., Nottingham—Finishing lace and other fabrics.
1443. W. Woofe, Gloucester—Implements for paring, hoeing out, snd clearing land.
1444. J. A. Manning, Inner Temple—Mode of intercepting and treating the sewage of London, and town and cities similarly situated.
1445. T. V. Flinn, Edward's-pl., Dynesford-rd., Camberwell-green—Sash-bars for the purpose of drainage.
1446. D. Campbell, Wemyss Castle, Kirkaldy, Fifeshire—A new grubbing and harrowing land roller.
1447. E. Pinchon and W. R. Harris, Elbeuf, France—Machinery for manufacturing healds or harness used in looms for weaving.
1448. E. E. D'Heurle, Paris—Boxes for keeping and measuring coffee, tea, and other substances requiring to be preserved from contact of the air.
1449. W. H. Preece, 7, Bernard-st., Primrose-hill, and J. L. Clark, Adelaide-rd., Haverstock-hill—Electric telegraphs.
1450. C. Erhard, 7, Rue des Navarin, Paris—Apparatus for boring wells.

Dated 28th June, 1858.

1451. I. Hammond, Winchester—Drawing the cartridge case from the barrel of a breech-loading gun.
1453. J. Luis, 13, Welbeck-st., Cavendish-sq.—Machine for reaping corn.
1455. G. Morris, Regent-st.—Shirt collars.
1457. C. W. Siemens, John-street, Adelphi—Cleansing tidal rivers.
1459. W. E. Newton, 66, Chancery-la.—A new mode of applying engraved plates, or electrotype or other substitutes for such plates, to the cylinders of printing presses to enable perfect impressions to be taken from the cylindrical surfaces of the plates.

Dated 29th June, 1858.

1461. F. A. Calvert, Manchester—Machinery for cleaning and preparing cotton, wool, and other fibrous materials.
1463. J. Shaw, Manchester—A machine to manufacture square paper and other bags.
1465. J. Harcourt, Broad-st., Birmingham—Spindle for locks and latches.
1467. W. Baker, 8, Albert-villas, Seven Sisters-road, Holloway—Constructing covered ways for the passage of sewage on the banks of rivers.

Dated 30th June, 1858.

1469. P. P. C. Barrat and J. B. Barrat, 33, Boulevard St. Martin, Paris—Machinery for digging, reaping, mowing, and performing certain agricultural operations.
1471. S. Fattorini, Milan (Italia)—An universal meridian, applicable to mathematical, geometrical, and precise instruments.
1473. W. Capstick, Liverpool—Wheels for carts or vehicles to run on common roads.

Dated 1st July, 1858.

1475. H. G. Pearce, Liverpool—Reefing the sails of navigable vessels.
1477. W. Clark, 53, Chancery-lane—Gridirons.
1479. T. Blinkhorn, Spalding, Lincolnshire—Construction of steam boilers and engines.
1481. H. W. Wimshurst, 7, Wilmot-road, Dalston—Manufacturing sheet metal.

Dated 2nd July, 1858.

1483. C. F. Vasserot, 43, Essex-st., Strand—Wire-conductor for electro-magnetic machines.
1485. F. Richmond and H. Chandler, Salford—Machines for cutting hay and straw.
1487. P. R. Hodge, 16, Chalcot-crescent, Regent's-park, and G. Spencer, 6, Cannon-street west—Regulating the recoil of springs used in railway engines, carriages, and station buffers.
1489. W. Sellers, Philadelphia—Machinery for turning metal shafting or bars and cylindrical rings and cutting screws.
1491. J. L. Clark, Adelaide-road, Haverstock-hill—Electric telegraph cables or ropes.

Dated 3rd July, 1858.

1493. T. Scott, Drummond-st., Euston-sq.—Dressing, separating, and cleaning seeds.
1495. S. Lees, Bury, and J. Jaques, Preston—Means for generating steam and economising fuel.
1497. T. Restell, New Kent-road—Breech-loading fire-arms and ordnance, and ammunition to be used in breech-loading arms.
1499. J. Chisholm, Bermondsey—A method of disinfecting and deodorizing or treating sewage and other matters, and structures and places.
1501. O. Sarony, Scarborough—Treating and coloring photographic pictures.
1503. A. V. Newton, 66, Chancery-lane—Soldering irons.
1505. E. Haeffely, Kearsley, Lancashire—Recovering oxides of manganese from products arising out of the manufacture of chlorine.

Dated 5th July, 1858.

1507. R. A. Brooman, 166, Fleet-street—Manufacture of cast steel.
1509. J. Hodgkinson, Atherton—Apparatus for kneading dough in the manufacture of bread.
1511. M. Nelson, New York, U.S.—Propellers for vessels.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

1360. B. Atwater, Connecticut, U.S.—Sewing machine. 16th June, 1858.
1431. C. W. Cahoon, Maine, U.S.—Machine for sowing seed or fertilizing material or other substances broadcast.—24th June, 1858.
1440. T. Lemon, Duke-st., Cardiff—Improving Cartwright's original patent chain harrow.—26th June, 1858.
1558. W. Northen, 14, Vauxhall-walk, Lambeth—The application of stoneware or earthenware, coloured or plain, to improved and original designs.—12th July, 1858.

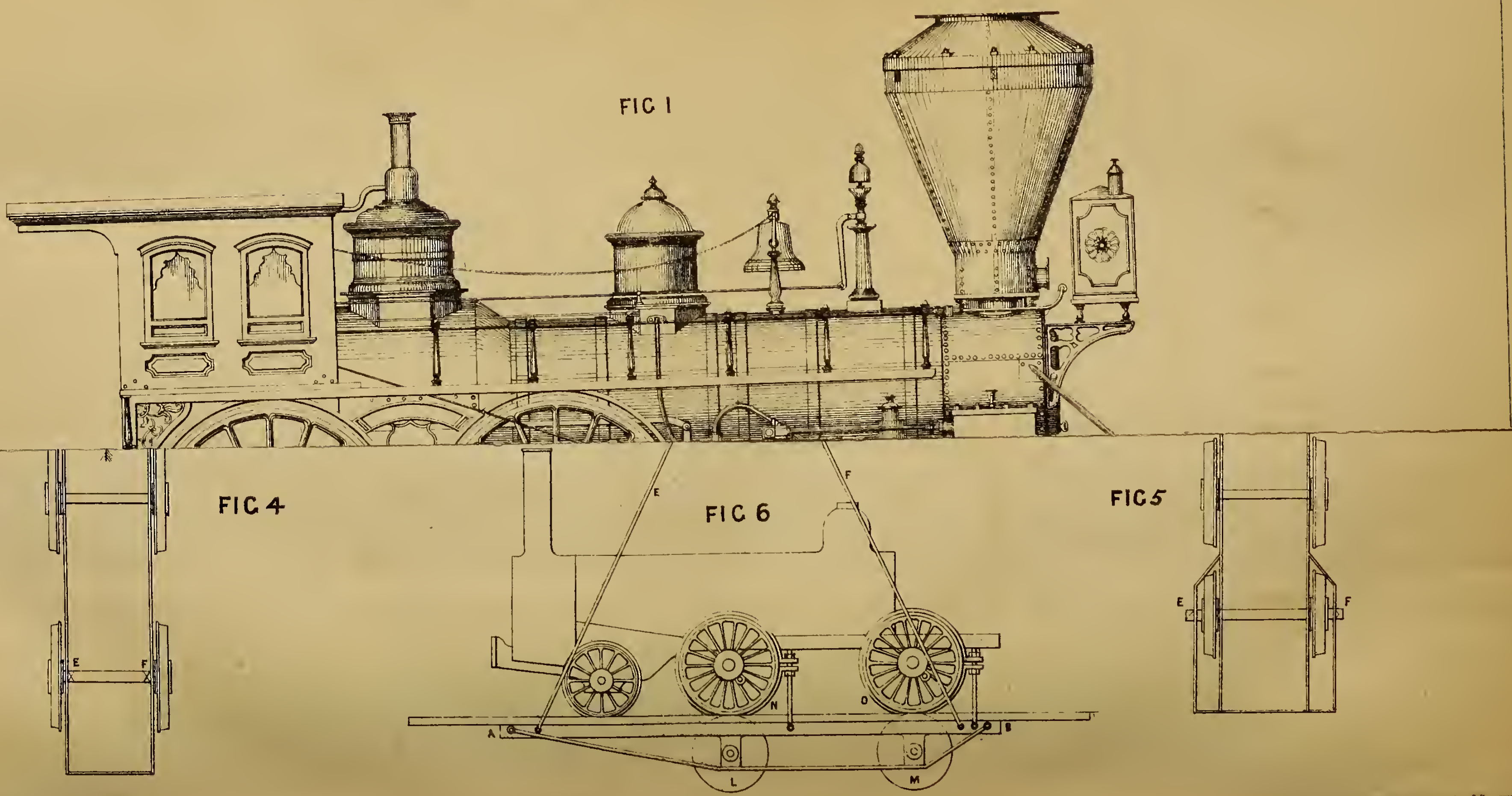
DESIGNS FOR ARTICLES OF UTILITY.

4103. June 28. J. Bowman, 15, Shaw's Brow, Liverpool, "Bowman's double-acting Travelling Blocks, for facilitating the removal of an under tier of casks."
4104. July 7. J. Cowley, Parks, St. Giles, Oxford, "An Improved Washing Machine."
4105. „ 9. Smith and England, Stourbridge, "Spade or Shovel."
4016. „ 10. T. H. Rees and J. D. Sprague, 54, Union-street, Southwark, "Improved Cork Bottle Stopper."

THE ARTIZAN. SEPTEMBER 1ST, 1858.

Plate 130

PASSENGER ENGINE, BUILT AT SCHENECTADY, NEW YORK.



W. Smith, C.E. del.

THE ARTIZAN.

No. CLXXXVIII.—Vol. XVI.—SEPTEMBER 1st, 1858.

THE MANUFACTURE OF LEAD SHOT.

(Illustrated by Plate cxxix.)

Considerable mystery is attempted to be thrown around the process of shotmaking by the few wealthy individuals by whom that branch of manufacture is carried on in this country. Thus considerable difficulties are thrown in the way of those who, from curiosity or for scientific or business reasons, desire to become familiar, practically, with the details of the operations connected with shotmaking; and as explanations of the process have been repeatedly asked for by correspondents, we have made arrangements for giving a series of plates illustrating the process, and exhibiting the most recent improvements which have been introduced in this branch of manufacture by the author of the designs, the first of which (Plate No. 129) we now present to our readers.

In the accompanying plate, Fig. 1 represents an elevation of a shot tower, the adjoining buildings being omitted; Fig. 2 a vertical section of Fig. 1, exhibiting the working floors and interior without the machinery and apparatus; Fig. 3 being an enlarged sectional view of the upper shotmaking floor, showing the furnace, &c., taken on the line E F of Fig. 5; whilst Fig. 4 exhibits a vertical section of the upper shotmaking floor, taken on the line, G H, Fig. 3, and at right angles to the line, E F, Fig. 5. Fig. 6 exhibits a vertical section of the lower shotmaking floor, taken on the line, C D, Fig. 8; and Fig. 7 is a similar view taken on the line A B, Fig. 8. Fig. 5 is a plan of the upper shotmaking floor, and Fig. 8 of the lower shotmaking floor, each exhibiting the position of the furnaces, collanders, the hoist, &c.

In our next, the details of these views will be given, as also a description of the process, which will be continued from time to time, as opportunities occur.

VALUE OF RAW AND MANUFACTURED MATERIAL.

In estimating the cost of any article, there are two essential elements to the calculation, viz.—the value of the raw material from which the article is produced, and the amount of labour expended upon the raw material before the required article is completed. It becomes a very interesting inquiry as to the proportions in which raw material, representing a certain value and labour, unite to make up the value of objects of art and manufacture.

In pursuing this inquiry it will be very soon perceived, that in many cases the original value of the material bears but a trifling, in some a totally insignificant relation to the value of the ultimate result; while in other objects of great utility and extensive consumption, the value of the article is but little raised above that of the raw material from which it is produced. There are two causes for this: First, the material itself may, like gold, possess a high value *per se*. Secondly, a material itself of small value may be subjected to an extreme amount of manipulation in the course of manufacture, or it may possess certain physical properties by which the necessary manipulation, not excessive in itself, is rendered hazardous or difficult. It must be evident, in carrying this principle to its full legitimate extent, that the value of any commodity in money, represents nothing more than the labour which has been expended in obtaining or producing it: for where the worth of an article is calculated from the cost of the raw material, and the labour of converting this material, it must be obvious that we are only, in the latter case, varying the form in which value, as the representative of labour, is put forward; for the price of the raw material itself is wholly governed, directly or indirectly, by the labour expended in its production. In a very few and especial instances, the peculiar qualities of a material may, in some degree, affect the question of value; but these are remote exceptions, and do not alter the general conclusion. The increased value of any substance arising from its comparative scarcity, as gold, platinum, and precious stones, must always ultimately be brought to the labour standard in fixing their worth—as their high price is the consequence of the great expenditure of labour required to seek for and obtain such materials.

The extent to which the value of raw material of any kind may be increased by being subjected to manufacturing processes, does not in the slightest degree depend upon the original value of such material; on the contrary, as will be presently proved, there are many cases in which materials of very insignificant worth may be endued with a money value far exceeding that which can be bestowed upon gold and the most costly gems. This depends upon the fact that the original material possesses specific characters or properties which render it applicable to certain purposes for which more costly materials are not available, owing to the absence of the necessary qualities from them. As a rule, it will be found that the proportion which labour bears to raw material in fixing the value of an article, is greater in the case of raw materials of small than in those of great value. Thus lead, copper, iron (cast and wrought), hemp, and flax, can all be endued with comparatively greater labour value than gold or silver—that is to say, the labour exceeds the value of the raw material much more in the former instances than in gold or silver; and with these two, the balance of the labour-value is again on the side of the least costly material.

To illustrate this position, let us suppose a quantity of raw material, worth in each case £1, to be manufactured as follows, the result would be very nearly,—

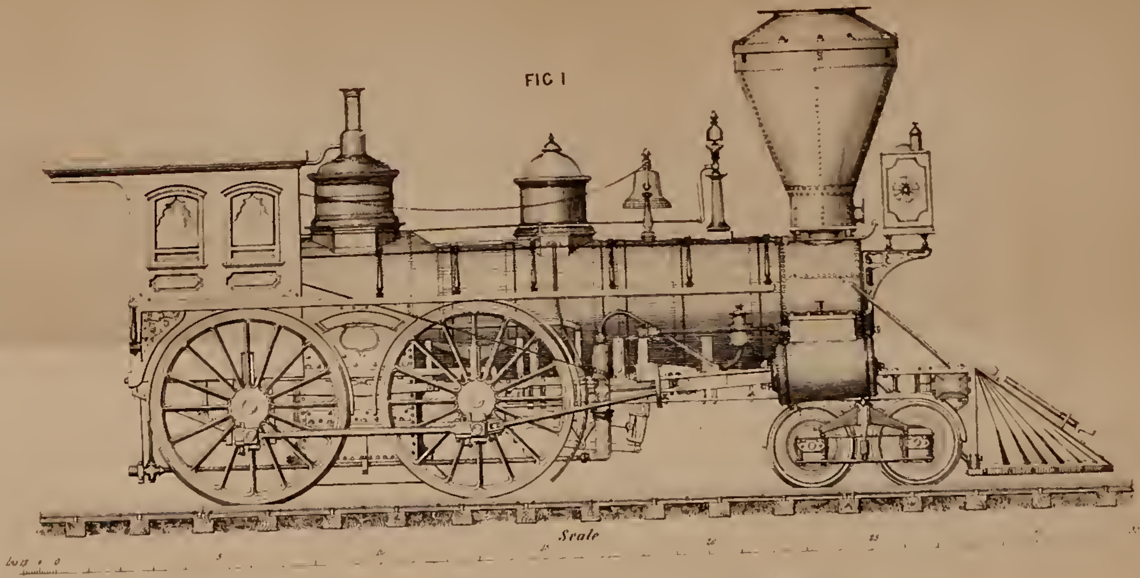
	£
Lead:—	
As sheets	1.32
Small printing type	30·00
Copper:—	
Household utensils	4·92
Fine metallic cloth	53·00
Iron (Cast):—	
Ornamental	48·00
Ornaments for the person (Berlin)	148·00
Iron (Wrought):—	
Twisted gun barrels	240·00
Penknife blades	650·00
Polished steel buckles, &c.	900·00
Needles	70·00
Scissors (finest)	450·00
Sword handles (polished steel)	980·00
Hemp:—	
Cordage and cable	4·00
Flax:—	
Linen	5·00

These figures prove that it is the least valuable raw material *per se* which is most susceptible of receiving a largely increased value by means of labour, and this will be more apparent if we consider that gold is rarely doubled in worth by any manipulation which can be bestowed upon it; and that, generally, in the price of gold articles, the labour element is greatly below that of raw material in worth.

Of all the instances, however, which could be brought forward to illustrate the relation which raw material and labour bear to each other, there is none more striking and conclusive than can be found in the manufacture of articles from steel. Referring back to the figures given above, it will be seen that in every branch of steel manufacture quoted, the raw material value is exceeded by the labour value in a very remarkable manner, the latter being in two cases 900 and 980 times greater than the former. There is no other raw material which is capable of having its value thus enhanced by labour; this doubtless arises

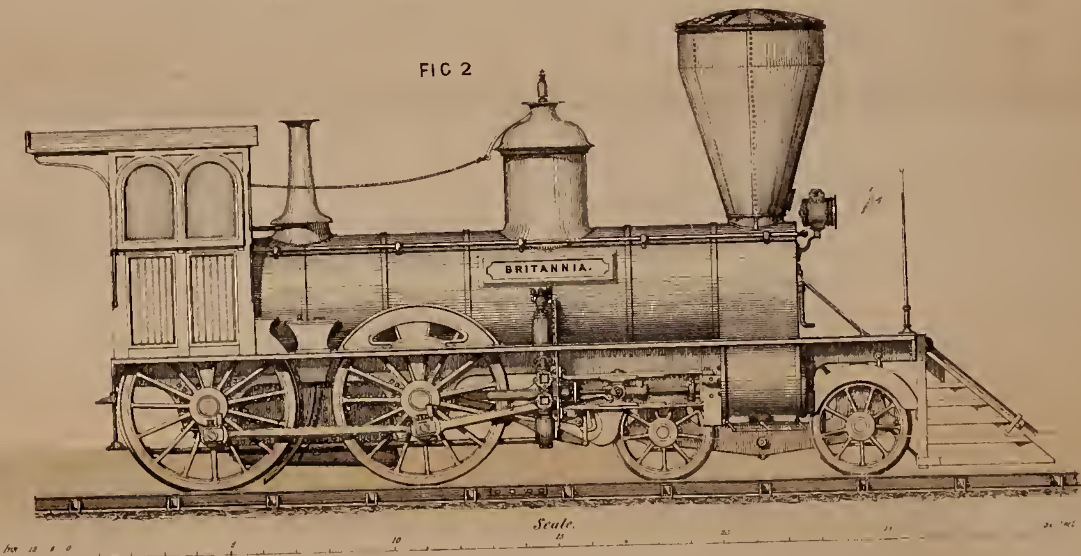
PASSENGER ENGINE, BUILT AT SCHENECTADY, NEW YORK.

FIG 1



GOODS ENGINE BUILT BY MESS.RS NEILSON & Co, GLASGOW.

FIG 2



FREIGHT ENGINE ON THE BALTIMORE & OHIO RAILWAY.

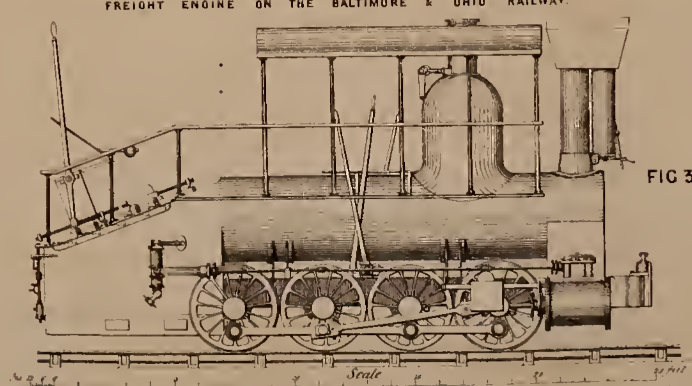


FIG 3

AMERICAN CHILLED WHEEL-RIM

FIG 7

LOCOMOTIVE STABILITY.

FIG 4

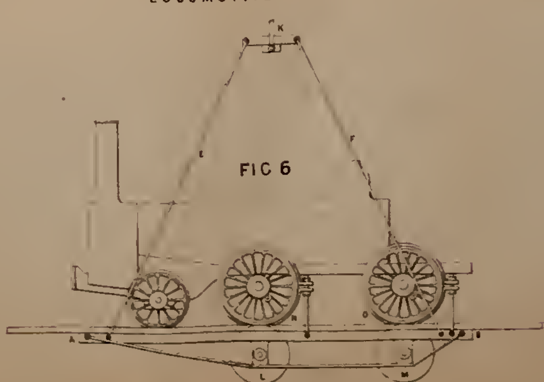


FIG 6

FIG 5

from the fact, that steel possesses properties which are wanting in every other substance, and which are just the properties which render it, and it alone, applicable to certain purposes in the arts. So much is this the case, and in such an eminent—nay, even astonishing degree does steel possess the power of receiving value from manipulation in the arts, that the cases already mentioned give but a faint idea of the extent to which this accession of value may be carried.

The property which, above all others, gives to steel the aptitude to receive high labour value, is that by which it is enabled to receive, at the workman's hands, any degree of hardness or softness which may be required in the manufactured article. The power of taking any degree of temper, from a hardness rivalling that of the diamond to the softness of common wrought iron, renders steel in many respects the most valuable of metals, and, as has been pointedly observed, the most important element of civilized life. It is, moreover, by means of this property, that steel is enabled to receive an amount of labour value in the production of articles which cannot be given to any other substance whatever. A well-known author has taken the instance of the balance spring of a watch as affording a remarkable example of the manner in which a certain material of comparatively little value may be enhanced in worth by the expenditure of labour; and it would be impossible to select a better proof of the extraordinary influence of the labour element upon the question of price. The balance or pendulum spring of a watch is made from the finest steel wire flattened, and so tempered that whilst its elasticity is left unimpaired, it is deprived of that extreme brittleness which would render it liable to be easily snapped. The process of manufacturing the wire itself is interesting, inasmuch as it is one of the few instances in which the wire is hardened and tempered before it is reduced to its ultimate fineness. When completed, the spring of an ordinary lady's gold watch weighs about 6-100ths of a grain; these springs are worth 4d. a piece; it would require nearly seventeen of such springs to weigh 1 grain: it follows, therefore, that a grain of steel subjected to the manipulation necessary to produce pendulum springs becomes worth 5s. 8d.—nearly the whole of which is labour value.

In producing springs for a smaller description of watch the increase of labour is enormous. There are three sizes of wire in general use in producing these springs. Specimens obtained from the manufactory of Messrs. Lambert, Oxford Street, Islington, are numbered respectively 42, 54, and 70. No. 42 is the kind from which the ordinary springs already spoken of are made. The other sizes are much smaller, No. 70 being absolutely minute. The price of No. 42 to the trade is 1s. per yard, the weight of which is 36-100ths of a grain. Consequently, 1 oz. of wrought iron, the value of which does not exceed 1-8th of a penny, converted into steel, and drawn into this fine wire, will produce 1,320 yards, worth £66. The second size, No. 54, is worth 2s. 6d. per yard to the trade, the increase of value being due to the additional labour and time required to reduce No. 42 to this smaller size. The weight of a yard of No. 54 is only 21-100ths of a grain. One ounce of steel would therefore draw into 2,200 yards of wire, the value of which is not less than £275; the worth of the raw material not, it must be remembered, exceeding 1-8th of a penny.

The third and smallest size of wire, No. 70, is only employed in making the springs of very small watches, such as are set in bracelets—more, indeed, objects of curiosity than use. The price of this wire is 20s. per yard, the increase of price being again only due to added labour, as the wire is in every case originally the same. There are but few workmen who possess sufficient skill to draw this wire; it weighs only 16-100ths of a grain per yard. One single ounce of steel would therefore draw into no less than 3,320 yards, or 1 mile 1,560 yards, or nearly 2 miles, having the almost incredible value of £3,320 per oz. In the state of steel wire of this extraordinary fineness, an ounce of wrought iron is worth as much as 830 oz. of pure gold, at £4 per ounce; or 13,280 oz. of silver, at 5s. per ounce.

As the value of the raw material was only 1-8th of a penny it follows that the enormous price of the wire is due solely to the worth of the labour bestowed upon it. The value of the labour element in this case exceeding that of the raw material by upwards of six millions of times.

This affords the most striking example within the range of manufacture and art of the fact that the ultimate price of an article does not in the least degree depend necessarily upon the value of the raw material alone, but that, independently of the value of the raw material, the labour element is the one which fixes the price of any commodity, and determines fluctuations from that price in all cases.

THE ATLANTIC TELEGRAPH CABLE—JOTTINGS.

By C. E.

Notwithstanding the evil predictions of the "Times," that the Atlantic Telegraph Cable could not and would not be successfully laid during the third attempt, which was made when the squadron left the Irish Coast on the 18th of July last, and notwithstanding also that everybody who wrote in the public prints, and who affected to know anything about the subject, expressed their opinion that the principle of construction of the cable was erroneous—that, in fact, it was a great blunder, and that, with such a form of cable, to expect to successfully pay it out and lay it down unimpaired, and in perfect electric continuity, along the bottom of the Atlantic, was sheer madness. Again, putting out of the question the absurdity of attempting to lay such a line of telegraph cable, the absolute hopelessness of ever getting intelligible messages through such a length of fine conducting wires, and if they were at all intelligible, they could not be got through at anything like a speed to make the means of communicating commercially profitable. Notwithstanding all this, and a great deal more, the Atlantic Telegraph Cable has been successfully laid, and is now duly at work, messages being constantly transmitted.

The "Times" also strongly advocated Mr. Allan's proposed form of submarine cable (which, if there be any *principle* of construction in it at all, is practically incorrect), instead of the form which, after repeated tests, and after the evidence of the most practical and competent authorities upon such questions, was adopted in preference to any other.

The desideratum in submarine telegraph cable-making, for employment in such situations as the Atlantic and other deep seas, is undoubtedly the construction of a cable possessing the most favourable conducting (metallic) element of the least specific gravity, combined with the greatest tensile strength, and insulated with the most perfect non-conducting material which can be plastically worked, or by which the conducting line may be readily, securely, and perfectly surrounded; and which non-conducting material will not be affected by changes of temperature or atmospheric condition, and in a different degree to the material it surrounds, and by which it is surrounded; and that it should adhere firmly to the conducting wire, and resist the internal cutting action which the splices or joinings of the wire produce in gutta percha. That whilst the insulating material possesses these qualities, and also that of bending in coiling without injury internal, external, or structural, the character of such material should be hard and incapable of being acted upon by extreme heat or cold, or of acting upon or being acted upon by galvanism or any of the chemical agencies probably to be met with in the course of construction, combination, or storing of the cable, or when it is submerged in the ocean.

Gutta percha has played the most important part in rendering available and practically useful the power of electricity, or electro-magnetism, as an agent for transmitting the thoughts of mankind with even greater rapidity than the lightning's flash from one hemisphere to another. But the minutely-cellular structure and, therefore, porous character of gutta percha, and the gradual change of condition or state which has been discovered and proved to occur, render it very desirable for some other and better material, composition, or compound substance, to be found and adopted.

Now, if such insulating material were found to-morrow, and proved to be perfectly successful, the protecting of the external surface of such insulating material, with the conducting wire within it, from external friction, longitudinal strain, and the effects of transverse short bends, or kinking, must be provided for by some metallic coating or sheathing; and if a thin tube of steel, of the requisite tensile strength, and capable of bending, could be drawn over the insulated conducting wire in a continuous length, there is no doubt that that would be the best description of protective covering for a deep-sea telegraph cable; but as this means of covering insulated electric wire is not practically available, the nearest approach would be the employment of fine steel wires, the ends of each wire being welded instead of being joined by splicing, as is ordinarily done, in the form of strands, laid spirally around the core containing the conducting wire at a suitable angle or "lay." The recent improvements in the manufacture of puddled steel, and in cast-steel making, by which the cost of production is so very materially reduced as to enable steel wire to be substituted for iron in the making of wire rope generally; as also the very important improvements in the treatment of steel wire whilst undergoing the process of drawing which have been recently made by Smith and Rollason, of Bromford Mills, near Birmingham, enable cast steel wire to be used for submarine telegraph covering (and for wire rope making), by which a tensile strength equal to about 100 tons per square inch may be obtained from such material.

The copper wire ordinarily employed for conducting-wires of submarine electric telegraph cables is generally defective, and much of it is totally unsuited for this purpose, containing, as it does, more or less zinc, and occasionally other metals in combination, thus rendering the wire subject to chemical change, and gradually reducing its ratio of electric conducting power; the wire becomes acted upon, and being rendered brittle, is liable to fracture by the simple transmission of currents. It is therefore desirable to substitute for this "copper wire" of commerce another metallic wire, if possible combining at the same cost greater electric conducting power, less specific gravity, greater strength, and equal ductility; and it is believed that the researches of Dr. Matthieson, of Torrington-street, Torrington-square, are likely to lead to this result.

The question of whether one or several conducting wires should be

inclosed within the same protective coating or covering of wires or wire-strands, is a question belonging to electric engineering, and beyond my "ken;" but both for mechanical and economical reasons (provided the electric local influence and lateral action considerations are not adverse), a cable containing three conducting wires is preferable to a single conducting wire applied as a core, and necessitating the expensive process of covering being performed upon it alone. And it is believed that the further experience gained by Professor Thompson, Mr. W. O. W. Whitehouse, and other practical electricians, in connection with the experiments previously to submerging, and now in the course of the successful daily working of the Atlantic Cable, will enable them to get over all the electrical difficulties which are supposed to interfere with the successful application of compound conducting cables for very long lines of submarine telegraphs.

One great defect in the present method of joining the ends of the conducting wires, is the "splices." These enlargements, wherever they occur, tear away and strip off the gutta percha from the wire, and thus produce one source of defective insulation, for as the cable is coiled or wound and unwound, and subjected to sharp bends, the gutta percha has a tendency to slide over the conducting wire; and as too often the copper wire is oxydised, this sliding of the gutta percha covering is more easily effected now in the neighbourhood of either a "splice" or a "kink" in the wire. When this slipping does take place, the gutta percha is occasionally opened, and the conducting wire laid bare. This has occurred more than once in the course of the late Atlantic expedition.

Reference to the respective means employed by the eminent firms of R. S. Newall and Co., and Glass, Elliot and Co., is here purposely omitted, although upon some early occasion it is hoped that much valuable information connected with the manufacture of the Atlantic cable in particular, and telegraph cables in general, will be given in the columns of The Artizan.

With reference to the mechanical contrivances and arrangements for paying out the Atlantic cable which were adopted, a description thereof is worthy of considerable space; although they must have been perfectly clear to the perceptions of such of the practical mechanical engineers who saw the machinery in Easton and Amos' factory, and were acquainted with the subject—and they were indeed, very few—that the machinery was far too ponderous for the purpose; that the friction of the parts which had to be overcome in hauling out the cable, or rather in hauling it through the machine, was very far in excess of what was necessary or judicious, and that the strain which would be consequently thrown upon the cable would, from the inertness of the machine upon any sudden demand being made upon it, be likely to prove, as it no doubt did prove, too much for the delicate thread-like cable which had to pass through it. The number of turns taken round the grooved drums was by one-half too many, and but for the excellence of the material, and skill and great care employed in the construction of the cable by both Messrs. Newall and Glass, it was demonstrated, during the first attempt, that it would not have stood the great amount of straining to which the four-fold coiling subjected it.

That a great practical blunder was perpetrated in erecting the delivery sheave, for paying out the cable, in the position in which it was fixed, must now be evident to those who witnessed its effect in preventing the actual strain from sudden jerks, &c., ever reaching the dynamometer; and, therefore, to expect an actual record of the strain, and a timely warning to those in charge of the breaks, was simply absurd. It is to be hoped that in making the arrangements for paying out submarine cables, a direct and gradually-inclined channel or passage may be made down to the water-line, instead of giving a nearly right angle bend to the cable in passing it out of the ship.

Never for an instant did any of those on board the *Agamemnon* and *Niagara*, who were competent to form a practical judgment as to the possibility of successfully submerging a sub-oceanic line of communication, entertain a doubt about their ultimate success; and with good weather, and no unforeseen cause of accident, the success was confidently anticipated which has so fortunately crowned the efforts of those engaged in this great and glorious undertaking.

THE GREAT RUSSIAN RAILWAY.

The first general meeting of the shareholders of this colossal undertaking has been held at St. Petersburg, when the Director-General, M. Collignon, laid before the assembly a report, from which we extract the following as the most important particulars:—

The plan of operations embraces a system of railway lines to the extent of 4,000 versts [about 2,666 miles].

1. The line from St. Petersburg to Warsaw.
2. The branch to be opened from this line to the Prussian frontier, towards Kœnigsburg.
3. The line from Moscow to Theodosia, by Kursk, and the region of the Lower Dnieper.
4. A line branching from thence to Kursk or Orel, passing by Dunabourg, and ending at the Port of Libau.
5. The line from Moscow to Nijni-Nov-gorod.

The first object of the Directors of so vast an undertaking is, in conjunction with the Prussian Government (who have already commenced the requisite works on their territory), to connect St. Petersburg with Kœnigsberg, and thus with the European system of railways.

2. To bring into active operation, and with the least possible delay, the line from Moscow to Nijni-Nov-gorod.
3. In order to commence in the present year the works on the southern line, between La Samara and Theodosia, so as to realize the junction of the Dnieper from a point taken below the cataracts, facing Ekaterinoslav, with the Black Sea.

The line from St. Petersburg to Warsaw has been for some years past in process of construction, but its completion has been retarded by political events.

The first 42 versts between the imperial residence of Tsarckoe-Selo and Gatchina have been opened for traffic. From Gatchina to Louga, the main body of the railroad is completed; and beyond this, at various points, earthworks have been commenced in the rough, and, indeed, to a considerable extent advanced, more especially from Louga to Pskow, and between Bialistock and Warsaw.

The Goverment, on its part, has taken important measures for securing the establishment and due working of the railway. The whole of the contracts for earthworks, the conveyance of materials, and for the supply of fuel for the locomotives, for many years to come, have been adjudicated ; orders for nearly one-half the quantity of rails required to reach Warsaw with a double line, have been given at the Oural works and abroad; a contract has been entered into with manufacturers in Berlin and Hamburgh for the construction of 2,000 carriages; and two contracts have been finally concluded with the engineering establishment belonging to his Imperial Highness the Duke of Leuchtenberg, one for the supply of 100 locomotive-engines, and the other for maintaining in working order the whole of the rolling stock on the line up to the year 1866.

Second Section.—Samara to Theodosia.—This important line will unite the river navigation of the Dnieper, taken at a point above the Cataracts, with the Black Sea. It will start from Ogren, on the Samara, a little below its embouchure into the Dnieper, and nearly facing Ekaterinoslav ; thence following the valley of the Dnieper to Alexiewska, passing by Alexandrovsk, and reascending the plateau of the German Colonies, approaches within 5 versts of Melitopol, crosses the Swack close to the saltworks at Genitchi, bears to the eastward of the Crimea, and reaches the Black Sea near Arabat, thus avoiding the heights above Theodosia. This line, from the river Orel to Theodosia, is about 539 versts in length.

The necessary measures are being taken, and the contracts have been settled, for executing the works across the Crimea. The line, bending to the eastward near Theodosia, passes within 16 versts of the small fortress of Ack-Manaï, on the Sea of Azof, near Arabat, thus connecting the navigation of the latter sea with the port of Theodosia, and avoiding the dangerous passage through the Straits of Yiéni-Kalé. The branch in question renders, indeed, Theodosia a seaport both on the Black Sea and on the Sea of Azof, and offers an advantageous means of transit for the natural products of that region, the principal of which is the anthracite coal from the banks of the Don, which descend by that river to the Sea of Azof, and will be taken straight to the port of Ack-Manaï for transit on the railway and distribution, whether at Theodosia or on other parts of the line. This same Ack-Manaï branch line will furnish, moreover, easy and direct access to the only coal field from which to draw the requisite fuel for the consumption of Theodosia proper, and for supplying the steam vessels which are likely to be attracted thither by the establishment of the railway itself. Further, it will afford a much required opening for the produce of the coasting trade of the Sea of Azof (chiefly building materials) from the regions lying between Ack-Manaï and Cape Kajendie, as likewise for the trading ports of Rostov, Taganrok, Marioupol, and Berdiansk, wherein the entire commerce of the Sea of Azof is at present concentrated, but which are of difficult access for the vessels that frequent the Mediterranean and the Black Sea.

The line from Koursk, or the River Orel, to Libau.—This line will branch off from the Great Southern Line to Koursk, whence it will open on the port of Libau. The preliminary surveys have been made between Dunabourg and the Baltic, and its completion offers not the slightest engineering difficulty. This line, passing by Mittau, would be the basis of future easy communication direct with the ports of Libau and Riga, and, if need were, of a branch line opening into the port of Windau.

The line from Moscow to Nov-gorod will follow, to a great extent, the present high road, passing by the principal cities and towns, and in the

very centre of a populous and productive country, in the direction of Chouïa and of the Iron-works of Mourom, which will be connected, through the river Oka, with the railway abutting on that river opposite Gorbatov. This line will pass near an important stone-quarrying neighbourhood. It will, for the first 8 versts from Moscow, be part of the Great Southern Trunk Line comprised between Moscow and Toula, to which allusion has already been made. Thus there will be but one starting-point in common. The establishment and bringing into working order of the section and stations between Gatchina and Louga (86 versts) was the first object of the promoters. As early as the 22nd August, 1857, the works were so far completed as to allow of the Emperor performing a journey thereon; but it was not until the 5th December following that the regular public traffic to Louga could be opened.

By the opening of the section from Gatchina to Louga, 128 versts of Warsaw line are brought into action, but the line cannot as yet be considered complete, various buildings being required for the traffic.

The works between Louga and Pskov are all but finished. This section will likewise consist of 128 versts. Beyond Pskov to Dunabourg and Warsaw the works have been in abeyance since 1857.

Up to the 31st December last, the stock in locomotives was as follows:—10 locomotives for passengers, 8 wheeled, built on "American" system; 6 goods-engines, 6 wheeled, same make; 6 engines, mixed make ("composite"), from abroad. This stock will shortly be increased by the addition of 74 engines, mixed make, and 4 special passenger-train engines.

According to contract with manufacturers at Berlin and Hamburgh, there will be, in 1860, a further addition of 300 passenger-carriages, and 1,800 vans for cattle and goods.

On the 31st December, 1857, there were on hand — 11 first-class carriages, 2 first and second class (composite), 11 second-class, 2 second and third class (composite), 50 third-class, 68 waggons (baggage and goods), 41 horse boxes, 220 flats, and 120 earth-trucks.

The mixed second-class carriages are 8-wheeled, on the so-called "American" system; all the others are 6-wheeled.

In order to facilitate the locking and unlocking of trains, the Directors state that they have reduced to four the number of wheels in nearly all the waggons forming goods-trains.

The line from Moscow to Theodosia will be 1,200 versts in length. Its abutments will be, on the one side the sea, and on the other Moscow. 1st Section—From Moscow to Toula.—The chief engineering difficulties on this line arise on the right bank of the Moskawa, between Moscow and the Oka, and the passage across that river. By the original plans, the line was to have passed near Kaszira; but on account of the enormous expense (estimated at 110,000 silver roubles per verst), and of certain engineering difficulties, this plan required to be modified, and it is proposed that the line from Moscow to Toula shall follow the valley of the Moskawa, on the left bank of that river, and cross the Oka a little below Kolomna.

At Moscow there will be but one starting station in common, both for the Theodosia and Nijni lines. This, according to the report, is an advantageous arrangement, namely, the union of two different railways for the first few miles of their extent. As regards the portion of the line between Moscow and Pskov, the arrangements as far as to Wladimir are all definitively made; the requisite contracts for the construction of the main works of the railway between Moscow and Wladimir having been entered into, with sufficient guarantees, so that it is confidently stated that the entire and, in a commercial point of view, highly important line from Moscow to Nijni wlll be opened for traffic in the course of 1861.

Up to December, 1857, the actual traffic had been confined to the 42 versts section between St. Petersburg and Gatchina: subsequently, it had been extended by 86 additional versts to Louga. The gross receipts up to the 31st December were 87,440 roubles 69 c., showing but a trifling excess (1,328r. 15c.) over expenditure, the working of the line in its present incomplete state being considered as scarcely more than experimental, and affording no fair criterion for the future. When the railway shall have reached Pskov, the goods traffic, more especially of that of firewood, is expected to be highly remunerative.

An interesting feature of this great undertaking is the establishment, in connection with it and at St. Petersburg, of a foundry and workshops, on a scale of unprecedented magnitude. The company have arranged for the purchase of the foundry and engineering establishment lately belonging to the heirs of His Imperial Highness the Duke of Leuchtenberg, for about two millions and a half of roubles. As it is contemplated that the business of this factory, however extensive hitherto, will but barely suffice for the demands of the new railway, the Directors announce that no further orders from other quarters or from abroad will be received. The portions of the Ducal foundry establishment heretofore celebrated for the production of works of art in bronze and "melchior" castings, have accordingly been disposed of by the railway directors for 145,000 roubles, which price includes the plant and tools, and the stock of art-castings ready for sale, or in course of production.

The "Technical Committee" attached to the Director-General is charged with the examination of all new schemes, proposals, inventions, &c., and takes cognizance of all questions of practical import relating to the working details and mechanical operations of the railway. The members must be resident in St. Petersburg. To these are annexed a body of engineers, specially appointed to manage the orders given for working material, &c., in France, England, or Belgium.

The Director-General is Inspector-General of Roads and Bridges in France; the two special directors belong to the same corps, one as engineer-in-chief, the other as engineer of the first class. The Company's engineering staff consists of 53 officers of the corps of Russian "Means and Ways of Communication," and 11 engineers of the French Imperial corps of Bridges and Roads (*Ponts-et-Chaussees*).

From the importance of the subject, we have considered that the above details may not prove uninteresting at a period when the attention of Europe is directed to one of the most colossal enterprises of the present day; an enterprise the results of which, as developing the hitherto latent resources of Russia, commercial, monetary, and industrial, are likely to prove of the highest moment, not only to the balance of power in Europe, but to the position, political and moral, of the whole world.

NOTES OF AN AMERICAN TRIP IN THE MONTH OF JULY, 1858.

By A London Engineer.

Having just returned from America, I send you a few extracts from my note-book, of my observations on the mechanical and general progress on that side of the Atlantic, which will, I believe, prove of interest.

At some iron-works I visited they have a rolling-mill where they roll plates 8 ft. wide, and the iron made there is of a quality equal, if not superior, to Lowmoor. Some charcoal plate I observed there was of a beautiful quality, possessing a uniformity of substance and freedom from blister, &c., which shows their anxiety to manufacture their own material of the best quality, and render them independent of any English iron: which they will soon do, the cost of production being at present their only drawback. They consider a $\frac{1}{4}$-inch plate of their charcoal iron equal in strength to a $\frac{3}{8}$ in. Lowmoor.

I went over some locomotive and machine shops, in one of which 600 men were at work. The various tools in use are excellent, of their own manufacture, and the finish of the work quite equal to anything I have seen in England. The links for the valve motion of the locomotives are forged solid, and slotted and finished complete by a machine adapted for the purpose. The stocks, taps and dies, guages, &c., were in finish and appearance quite equal to Whitworth's. This I am enabled to state from there being several sets of his in the shops, which I took the trouble to compare with those of their own make.

They are fitting the locomotives, tenders, and cars, *with chilled cast-iron wheels*, and taking off all the wrought iron English ones. The driving wheels of the locomotives, however, have wrought iron Lowmoor tires, which is the only English iron they will use. (This iron is everywhere spoken of in the highest terms, either in the shape of tires, bars, or sheets, while loud complaints were made of other English iron—no doubt the trash got up "for exportation," "shippers supplied," &c.) I saw in one of these works alone 800 English wrought iron wheels, which were in a horrible state, literally knocked to pieces. The cast wheels are made of chilled American charcoal iron, and are exceedingly nice castings. Some were broken to show the quality, and were very close grained, with the "chill" penetrating with great regularity about $\frac{1}{2}$ in. into the metal. It had much the appearance of bell metal in lustre. I saw some of the shavings from the boring of one of the engine cylinders, which were several feet in length, and formed a perfect convolute of many turns, about 3 in. in diameter, and had almost as much elasticity as a watch-spring.

From the samples of iron of different makes that were shown to me, I think it behoves our makers seriously to consider whether it is not time to give up the system of making a "cheap" article for "exportation," which is put forward as *being of a quality far beyond what it really is.* Let them take a hint from the present state of things at Para, in the Brazils, where, in speaking of the English tools, axes, &c., it is said that "the temper of the steel (*if indeed there be any steel in them!!*) in the tools which we receive from Great Britain, is so ill-adapted for working the hard woods of this country, that such tools are *perfectly useless and unsaleable!!!* whereas those which *come from the United States* may be truly said to command a preference from their *superiority of quality.*" It is the rage for what is miscalled "cheapness" which has impaired this branch of manufacture, in which we claim to stand pre-eminent. Let them also remember the "tools" supplied to our men in the Crimea! They make their own springs, axles, and brass-work, in most of these factories, and all which I saw appeared of a very excellent quality.

The bricks in common use are splendid, and totally different from the trash called bricks in London. They are made entirely of clay, and are exceedingly solid and heavy, the arris being as sharp as though they were

cut out of solid stone. The best bricks, called face brick, look more like a piece of cheese cut into shape with a keen knife, than anything else I can mention: they are so smooth, clean, and sharp. They are rather proud of their bricks, and now make a great quantity by pressure. I think we—or, at least, our brickmakers—might endeavour to improve the quality of ours, and use clay rather than mud and slime, as is too much the custom on the Thames.

At one of the railway stations I observed several trucks entirely filled with spade handles, packed in dozens, and sent up some hundred miles or so from the country. These were entirely machine made, and had a finish about them which was very surprising. They take their machinery up into the woods, cut down the timber, form it into the various marketable articles, and then send these to market; and do not cut down the trees, and bring from a fourth to a third of useless material to where the demand for the articles exists, and then manufacture. This would, I should think, furnish a hint for some of our enterprising speculators.

I have also looked into several of their agricultural implement depôts, where I find a manifest superiority in finish and general principles of application which were quite at variance with the generally-received idea that "they are in too great a hurry to finish anything." The handrakes and other tools are beautifully made and finished, of a tough yellowish kind of wood; and the pitchforks resemble the West of England steel forks in shape and length of tine and elasticity of handle, which give great power to the user.

The light four-wheel carriages in which they drive about are very elegant, and resemble the "trotting traps" formerly in vogue. I do not see why they should not be more extensively used in England, as they are very strong, very light, and have great accommodation—in fact, from the knocking about I have seen them experience, I am sure the plea (which, from their slight appearance, would be sure to be urged against them) that they would not stand our work, cannot be for a moment maintained. Their horses in general use are very superior, and they evidently pay great attention to keeping them in good condition. I can safely say that such an abomination as a "London cab" could not be found in the States, and I think I may say would not be tolerated! Cannot we take a hint from them and start a decent set of vehicles—at least, equal to their "hacks," as they term their cabs? I find them quite equal to the generality of four-wheel traps which are jobbed in London, and in no way resembling our disgraceful vehicles, which should now give place to more decent and commodious conveyances.

I could not fail to notice the almost universal employment of vulcanised India rubber tubing for the supply of water, both in steamers, ships, and ashore, where it seems to be fast displacing the leather tubing. In quality and freedom from smell, it very much resembles "Perreaux's Patent," which you described some time since in The Artizan; and the employment of India-rubber for various purposes seems to be rapidly increasing.

I was also much pleased, when at Boston, by inspecting the *Voyageur de la Mer*, built and engined in that city for the Pacha of Egypt. She is an iron vessel of about 1,200 tons, ship rigged, and is exceedingly handsome; her engines are oscillating, two 54 in. cylinders, with double piston rods coupled direct to the crank; but I do not admire them, as there are too many new-fangled "cut-offs," "pressure-gauges," "indicators," &c., about, making the engine-room look like a show-room of some celebrated maker of such articles. The engines, also, are not well arranged for inspection and attention when running, and the stoke-hole is very small and excessively hot; in fact, the engines even now, after having had a *second* set of larger boilers, do not do their work, as the ship under full steam only does 9 knots, while she easily sails 12. Her model is faultless and a credit to her designer, who, in common with all on that side of the water, is sufficiently alive to the merits of Mr. Scott Russell's "wave-line" principle as to introduce it wherever speed is required. Her fittings are very costly and handsome, and with her rigging, most creditable to those who carried them out. She is provided with a most pleasant substitute for that most intolerable nuisance the steam-whistle (which anyone who has crossed to Halifax in a steamer will not forget in a hurry) in the shape of a *steam organ*, or "calliope," as they term it. I had the pleasure of hearing some pretty airs neatly played on it by one of the gentlemen on board; and it has also a barrel turned by a handle which plays several tunes. The sound of this instrument has been heard a distance of six miles. She has several heavy guns on Dahlgren's principle, but I do not know what her armament is. She had one in the bow, and one in the stern.

I was also told, that in order to ensure the greatest efficiency and security in their boilers and other vessels subjected to steam of high pressure, it was their intention to *drill* (by means of an arrangement of two or more drills), *instead of punching*, the rivet-holes in their boiler-plates: so that the danger arising from the serious deterioration of the plates from the present system of punching, with punches frequently taper, bad bolsters, and little or no attention to the precision with which the holes tally with the marks from the templet, which leads to the odious system of *drifting them up*, all proving to be more or less a fruitful source of weakness in boilers, and so detrimental to their strength—will by these means be totally avoided, and greater security ensured in the use of the truly economical high-pressure steam.

I have no doubt in my own mind that had the holes in the plates of the locomotive boiler which exploded with such fatal results a few weeks since been *drilled, instead of punched*, we should not have had this accident to deplore.

I trust our boiler-makers and engineers will seriously consider this subject, with a view to its immediate adoption, and keep punching for water tanks, caissons, &c.

DOINGS IN DUBLIN.

FROM OUR OWN CORRESPONDENT.

The state of the Liffey appears to have become a topic of greater interest to the Dublin citizens than we ever remember it to have been before. Why all parties should be thus rushing into print we know not, unless it be that some months ago we revealed to the public the merits of Mr. Sloane's method of dealing with the evil.

The Corporation are about advertising for designs for the improvement of Carlisle Bridge, and a proposition is being made by a friend of ours for the construction of a plain girder bridge, to occupy the site of the present metal bridge, which has become inadequate for its purpose. The old materials will be sold, or taken and allowed for by the contractors.

The Commissioners of National Education are about enlarging the Model Schools, and having applied for tenders, several were sent in, when they accepted the lowest. All preliminaries being complied with, the fortunate contractor discovered that he had made a mistake in his figures, and that he would be unable to do the work for what he had stated. Whether the Commissioners will oblige him to proceed or not, we are not in a position to state.

The long-wanting electric time-ball has at last been taken in hand, and the plans, &c., are preparing, under the direction of Sir William Hamilton. The exact position on the Quays has not been determined on, but there are thoughts of placing it on the summit of a campanile in connection with the Custom House. Perhaps a more desirable position would be somewhere on the North Lots.

Perhaps the largest sawing and wood-planing establishment in the kingdom is now in course of erection by the Messrs. Martin, on the North Wall, for the supply of wrought timber for their home and rapidly-increasing Australian trade. Already several of their ships have left the port of Dublin for Melbourne, taking, as portion of their cargoes, large quantities of doors, sashes, joists, rafters, flooring, and other timbers. The works are to be supplied with the most approved sawing, planing, morticing, and other machines; amongst others, Horn's improved plane—a drawing of which was published in The Artizan for April, 1858.

An establishment of somewhat similar dimensions, although not so large, is erecting in Brunswick-street, by the Messrs. Meade and Co., for sawing and planing—the chimney-shaft of which, if we may judge from the great dimensions of its base, bids fair to be the largest in the city.

Since our last letter, we have ascertained that the bridges over the dock openings on the quays, so very much required in place of the present nuisances, have been given to the eminent iron founders, Dalgliesh and Co. They are not to be built in accordance with the plans of the Board of Public Works, but according to plans furnished by the contractor!

We believe that Mr. Dargan has not been engaged to construct the engine-well, &c., of the graving-dock, it having been given without competition to a Mr. Kavenagh, who has engaged the Messrs. Twomy, of the Phœnix Iron Works, to erect the necessary pumping apparatus.

The Messrs. Twomy have been also declared the contractors for the erection of new stores, &c., for the Port of Dublin Corporation.

The great smelting works of the Mining Company of Ireland are fast progressing at Ballycorus, under the superintendence of the Messrs. Carmichael and Jones, architects. The fittings are of a most superior description, and all the most modern appliances for the cleansing, grinding and reduction of the ore have been obtained, and will be shortly in working order.

The new station at Mullingar has been finished from the plans of Mr. Wilkinson, who has in hand the remodelling of the Marquis of Sligo's princely residence at Westport, in Co. Mayo.

The Dublin and Howth Railway Company have laid out a large portion of their lands in villa lots, which will, no doubt, provide several of our architects with exercise for their pencils.

INSTITUTION OF ENGINEERS IN SCOTLAND.

Since the publication of Professor W. J. Macquorn Rankine's inaugural address, delivered at the Philosophical Societies' Hall, Glasgow, and given at length in The Artizan for April last, the establishment

of the Institution of Engineers in Scotland has attracted considerable attention, and its progress and prosperity are now looked upon as certain by those who have taken an active part in promoting its establishment.

Amongst the many interesting Papers which have been read, and which for number and interest bear highly creditable comparison with the oldest engineering institutions and general scientific societies in this country—we have selected three or four of the Papers read at their meetings for publication, and which will be found elsewhere.

It is highly gratifying to find an amount of *esprit de corps* amongst the Scotch engineers such as we discover on carefully perusing the first volume of the "Transactions of the Institution of Engineers in Scotland," and we sincerely hope that the work so well begun will go on and continue to increase in extent and usefulness; that the well-known sound practical scientific attainments for which Scotch engineers have always ranked pre-eminent, will find a field for display on native soil, and that their possessors will not, as heretofore, be forced to seek in some foreign institution the opportunities for communicating the result of their practical labours, or of their experimental researches and scientific investigations.

We therefore in all sincerity wish a hearty success to the Institution of Engineers in Scotland.

DESCRIPTION OF TWO PAIR OF HORIZONTAL PUMPING ENGINES.

By E. A. Cowper.*

In continuation of our report of this interesting paper, we give the following abstract of the discussion:—

Mr. W. S. Garland inquired, what was the average duty obtained from the Yarmouth pumping engines; it appeared from the particulars given to be only about 60 million lbs. per cwt. of coal.

Mr. E. A. Cowper replied, that the duty was about that amount in the present mode of working the engines—namely, only one day at a time for six hours, and was of course considerably lowered by their not being in constant daily work; the present consumption of 3·9 lbs. of coal per H.P. per hour net work done, would most probably be reduced to a little below 3 lbs. in that case. The small size of the engines would also make the consumption rather higher than in larger engines.

Mr. W. S. Garland thought the pump-valves in the Crystal Palace engines appeared rather small in proportion to the size of the pumps.

Mr. E. A. Cowper replied, that the valves had each four openings for the discharge of the water, instead of only two, giving a total area of 63 sq. in. when the valve was full open, which was quite large enough to allow a free passage of the water, as the engines were rather slow in the regular working speed of the piston. A very small amount of lift really took place in practice with that construction of double-ring valve, on account of the free and direct passage given for the discharge of the water through the four openings; as was shown definitely by the diagram exhibited, which had been recently taken by Mr. Crampton from the pump valves at the Berlin Waterworks.

Mr. W. S. Garland considered the rise and fall of the valve shown in the diagram was remarkably regular; he should have expected a much more sudden motion than was shown by the curve; the action of the valve was highly satisfactory, and it must work very quietly, without any blow in shutting.

Mr. E. A. Cowper said that no blow whatever was perceptible in the working, and the diagram showed that the valve was very near the seat before the crank turned the centre, so that no concussion was produced in shutting. When the valve was so loaded as to keep it pressing constantly upon the water, and prevent it from being thrown up against the stop, and the motion of the pump was also controlled by a crank, it was impossible to get a blow in shutting; he had found that in the present case a load of about ½ lb. per square inch was sufficient with that form of valve at the ordinary speed of working, on account of the small lift of the valve. In the case of the old butterfly valves, the valve was shut by the column of water endeavouring to return, instead of by its own weight, and therefore shut with a violent blow; and the difficulty was greatly increased by the suddenness with which the motion of the water was checked at the end of the stroke in engines without a crank.

Mr. G. F. Muntz inquired, whether the full extent of lift of the valve was shown in the diagram taken from the Berlin valve, as it seemed very little lift for so large a valve.

Mr. E. A. Cowper replied, that the diagram showed the full extent of the actual lift of the valve, which was shown to be less than ½ in. in working; but the whole clearance was 1½ in. before striking the stop. The diagram had been drawn full size by the valve itself, by means of a small vertical rod attached to the top of the valve, passing up through the valve chamber and through a stuffing box, and carrying a pencil at its upper end, which traced the diagram upon a board moved transversely with the full stroke of the pump piston. The stroke of the pumps was 3 ft., making twenty-eight revolutions per minute, or 168 ft. per minute speed of piston. He had had several of these valves in use for a considerable time, which had proved very satisfactory in working; but this was the first from which a diagram of the motion had been taken.

Mr. C. W. Siemens was acquainted with the pumping engines at the Berlin Waterworks, where there were twelve powerful beam engines, coupled in pairs at right angles with fly-wheels, and working vertical pumps under a pressure of 160 ft. head of water. The present double ring valves allowed an easy and unrestricted motion of the water, as the joint circumferences of the four openings gave a large area of passage with a little lift of the valve.

With regard to the employment of the crank and fly-wheel for pumping engines, in place of the Cornish system of lifting the water by the weight of the plungers, it was true that a large fly-wheel with a great weight in the rim, running at a considerably higher speed than the weight in the Cornish engine, had the advantage of more *vis inertiæ*; but only a limited fluctuation in its speed was available, and the weight was never stopped as in the Cornish engine, where the whole weight of the pump rods was stopped and started again at each stroke. It was therefore to be expected that a greater economy could be obtained by the latter plan in case of very great lifts, a larger proportion of moving power being absorbed at the commencement of the stroke, allowing the expansion to be carried to a higher degree by admitting of greater extremes of pressure in the stroke. He accordingly thought there were cases, such as pumping from deep pits, where the Cornish plan would prove the most economical, the pump rods falling gradually by their own weight, and being then lifted by the free action of the steam in the cylinder; but for many cases, such as low lift pumps, the horizontal direct-action construction was preferable. He observed that the engines described had not been designed for such a high degree of economy as was attained in the Cornish engines, since the steam was cut off at only one-third of the stroke, and there did not appear to be a steam-jacket to the cylinders. He had found a great advantage in employing a jacket, not only round the sides of the cylinder, but also at the ends, and it was more important to have a jacket at the ends than round the sides; for on the steam first entering the cylinder, a much larger extent of surface was offered to it by the end than by the small portion of the sides then exposed. When the cylinder was not protected by a jacket, the end of the cylinder being cooler than the steam on first entering caused a portion to be condensed, which was partly evaporated again in the latter part of the stroke, when the pressure and consequent temperature of the steam was lowered by expansion. The effect of this generation of steam in the cylinder was to increase the pressure at the end of the stroke beyond that due to the expansion; and the line of the indicator diagram was thus raised in the latter part of the figure above the regular curve of expansion. But this did not appear to be the case in the indicator diagram from the Crystal Palace engines, which showed the steam entering the cylinder at a total pressure of about 34 lbs. per square inch, cut off at one-third of the stroke, and expanded down to a final pressure of only 9 lbs. instead of 11 lbs. due to the expansion.

Mr. E. A. Cowper observed, that there appeared from the indicator diagram to be a little loss of pressure at the end of the stroke, due to some other circumstance. The cylinders of these engines were made without steam jackets for economy in construction; but he always employed a steam jacket wherever practicable. He observed that the indicator diagram showed a very square cornered figure, owing to the action of the cam motion, particularly on beginning to exhaust, the exhaust being opened to the full extent at once. The cam motion proved highly satisfactory in the engines working at only about fifteen revolutions per minute; but he thought it would not be applicable in that particular form for a high speed, such as 100 revolutions per minute, since it would be liable to cause concussion and wear of the rods and joints.

The Chairman quite agreed in the value of the steam jacket, and of protecting the ends of the cylinders. Marine engine cylinders used to be made with steam jackets, and then lagged with felt and wood; the top and bottom were cast hollow, and protected from radiation by these spaces being filled with sawdust or other non-conducting material. He inquired whether the india-rubber valves of the air pump were fixed tight on the centre pin, or whether they were free to revolve on their guides by the action of the water, to prevent the valve from always beating on the same place.

Mr. E. A. Cowper replied, that the valves were not nipped tight by the centre pin, but were an easy fit upon it; if the india-rubber discs were nipped in the centre, they were liable to cockle up on the edge, and the shape was thereby injured; and when the shape was injured in fixing, they would not work well afterwards; but when the shape was uninjured, and they were left just free, they worked satisfactorily, and were very durable, and he thought they made the best air-pump valves. He

---

* Read before the Institution of Mechanical Engineers.

had had these valves at work in other engines for a year and a half, and they appeared still in as perfect order as when first put in. The conical injection valve used in the condenser gave a highly efficient action in condensing the steam; it threw a thin conical sheet of water into the condenser with the full pressure due to the vacuum, or 20 to 25 ft. head of water; the water striking against the sides of the condenser was well distributed throughout the chamber, and a vacuum of 13·6 lbs. below the atmosphere was by this means maintained, giving a back pressure of only 1·1 lb. per square inch on the piston.

The Chairman observed, that the first india-rubber valves were fixed tight on the centre pin, so as to work always in the same position on the seat; but they had failed by becoming completely cut through by the bars of the grid after wear. Some valves had lately been tried with the bottom grid dished a little, the sides inclining upwards at an angle of 22° or 25°, the india-rubber valve being also made of the dished form; this allowed a more free action of the india-rubber disc, with less injury to the material.

Mr. James Brown remarked, that the passage of the water through the grating caused the valve in rising to have a twisting action, preventing it from falling always upon the same part; and it was the invariable practice to make these valves easy on the spindles in the engines constructed by Messrs. James Watt and Co.

The Chairman observed, that when the grid was dished all round, the disc rose bodily, and seemed to twist a little in falling, which prevented the india-rubber from always beating on the same place.

Mr. G. F. Muntz inquired, what was the highest speed at which the engines could be worked without any concussion being produced in the double ring valves of the pumps.

Mr. E. A. Cowper replied, that the Yarmouth pumps were worked at a speed of 180 ft. per minute; those of the Crystal Palace engines had a regular speed of only 90 ft. per minute, but they had been worked at twenty to twenty-one revolutions per minute, or 126 ft. per minute, without any concussion of the valves being perceptible, the weight of the valves being sufficient to cause them to follow the water closely at that speed. If the pumps were required to be worked at a high speed, or under a great head of water, the weight of the valves should be increased so as to give a pressure of 2 or 3 lbs. per square inch, instead of only a little more than ½ lb., as in the present instance, in order to reduce the height of lift of the valves, and the extra pressure would involve the loss of only a small additional head of water.

The Chairman asked, what was the difference in principle between the double ring valves now described and the plan of ring valves that had been tried before in marine engine air-pumps, and had been found to answer well, consisting of two separate rings, each rising independently, and guided by a number of bolts holding a fixed ring, which prevented their rising too high, the valves being of an inverted T section.

Mr. E. A. Cowper said, the main point of difference was the greater relative length of the centre guide, whereby greater steadiness of motion was obtained. In the valves with two separate rings there were two short separate guides working upon the centre spindle, which were liable to cant and get jammed crossways in falling, if the valve were not sustained in a truly horizontal position; but in the double ring valves of the Crystal Palace pumps the guide was a long tube on the centre spindle, 4½ in. long and 1¾ in. diameter, giving a proportion of height of two and a half times the base, and thereby ensuring a steady fall of the valve. The action might be illustrated by that of a long narrow drawer, which would slide smoothly if pushed in endways; whereas a short wide drawer would stick, owing to the line of thrust being within the angle of friction. The ordinary form of double-beat valve was also partly liable to the same objection; for although the length of guide was considerable, its diameter was so large as to exceed the length, the base consequently subtending a large angle; the valve was therefore not so safe from getting jammed in closing, and did not fall so freely, as if steadied by a longer guide; and in the case of an engine without a fly-wheel, if the valve stuck at all, it caused the engine to come down with a run. With the double ring valves, however, in consequence of the greater relative length of guide obtained, there was scarcely any wear of the guide or of the centre pin, and the valves worked very steadily.

The Chairman asked, whether there were many pumping engines working the pumps horizontally.

Mr. W. S. Garland did not know of any others working the main pumps in that manner; some engines had been made at Soho working the air-pump horizontally, but not the main pumps.

Mr. Samued Lloyd considered a great advantage was gained in the fly-wheel pumping engine from the capability of working at even double the speed of a beam engine, and it was also much safer from accident; a case had occurred at their own works where the pump valve gave way in a beam engine of 60 or 80 H.P., and caused the breakage of the beam and much mischief, which would have been prevented by a crank and fly-wheel to the engine.

The Chairman observed, that in a pair of 50 H.P. high pressure direct-acting engines with vertical cylinders, constructed by Messrs. Maudslay, Sons and Field, for pumping from the Nile in Egypt for the purpose of irrigation, the cylinders of which were 28 in. diameter, with 6 ft. 6 in. stroke, the piston rod was continued downwards, and connected direct to the pump rod below, without either beam or fly-wheel, and worked a pump of 36 in. diameter and 6 ft. 6 in. stroke. The 40 H.P. high-pressure engines erected on the South Devon Atmospheric Railway by the same firm were constructed with a fly-wheel, the pair of engines being coupled together, and they worked well; they had vibrating cylinders 33 in. diameter and 6 ft. stroke, and the air-pumps for exhausting the air from the tube were also vibrating.

Mr. W. S. Garland remarked, that a superiority had been found in economy in a fly-wheel pumping engine compared with a Cornish engine. In the case of a pair of fly-wheel engines erected for the New River Company at Stoke Newington, near London, by Messrs. James Watt and Co., the result of nine months' working gave eight to ten millions per cwt. more duty than the average performance of the best Cornish pumping engines at waterworks, and eleven millions more duty than the double cylinder engines working at the same establishment.

The Chairman inquired the size of the engines, and whether the cylinders were well protected from radiating.

Mr. W. S. Garland replied, that they were beam engines having 60 in. cylinders, with 8 ft. stroke, making ten to twelve revolutions per minute, worked with steam at 30 lbs. per inch above the atmosphere, cutting off usually at 1-5th of the stroke, with the means of doing so at 1-10th, and expanding down to about 10 lbs. below the atmosphere; the cylinders had steam jackets and were well cased. Each engine had two pumps of the "plunger and lift" kind, the outer pump having a plunger of 22 in. diameter and 7 ft. stroke, and the inner one a plunger of 30½ in. diameter and 4 ft. 9 in. stroke; both working under a head of from 80 to 83 ft. of water.

The Chairman proposed a vote of thanks to Mr. Cowper for his Paper, which was passed.

DESCRIPTION OF A STEAM PUMPING-ENGINE NOW BEING CONSTRUCTED FOR THE GLASGOW WATER COMMISSIONERS AT THEIR RESERVOIR IN DRYGATE STREET.

By Mr. D. Mackain (Glasgow).*

This engine is represented in side elevation in the accompanying woodcut, Fig. 1, and in plan in Fig. 2, the pump being shown in section in the plan. The engine consists of a horizontal cylinder of 25 in. diameter, with a stroke of 4 ft., and is provided with a fly-wheel. It works two horizontal pumps of 14 in. diameter, with a stroke of 4 ft., and by means of two ram plungers.

This engine is being constructed from the designs of the writer, and is nearly a counterpart of another engine which has been in use for some years at the same place; the difference being that in the case of the earlier engine, the two pumps were closely connected, having only a plate with a stuffing-box between them; whilst in the engine now being made there is a space of about 3½ ft. between the pumps, permitting each to be more easily inspected and repaired.

The inducements for constructing the engine in this form are—1st. The lessened cost of building the engine-house, nothing beyond a foundation being required. The side walls are merely for shelter from the weather, and are in no way connected with the engine. 2nd. The construction of the engine, requiring no heavy weights to be raised when the ordinary repairs of pumping-engines have to be made, which, at a station where there is no staff of men beyond the engineman and fireman, is found to be important.

One of the upper clacks is represented in vertical section in Fig. 3, and in plan in Fig. 4. It is of brass, and consists of an annular ring, working on a spindle in the centre. With this construction the water passes through the centre of the valve when it is raised, as well as round the sides. The extreme diameter is 15½ in., that of the central space being 6 in.

The lower clacks are of the usual butterfly-valve shape, of leather strengthened with iron plates. A valve of this kind, in use in the engine at Dalmarnock, is represented in vertical section in Fig. 5.

The valve seats, or cases, are all bulged out round the sides at A, so as to permit the free passage of the water past the valves when the latter are raised.

The piston-rod of the steam-engine passes through both ends of the cylinder, being connected to the fly-wheel on one side, and to the pump plungers on the other side. The plungers slide in brass collars in the pumps, and are connected by pump-rods, which pass through stuffing-boxes, so that every precaution has been taken to prevent the "sagging" to which horizontal engines are liable.

---

* Paper read at the Institution of Engineers, in Scotland.

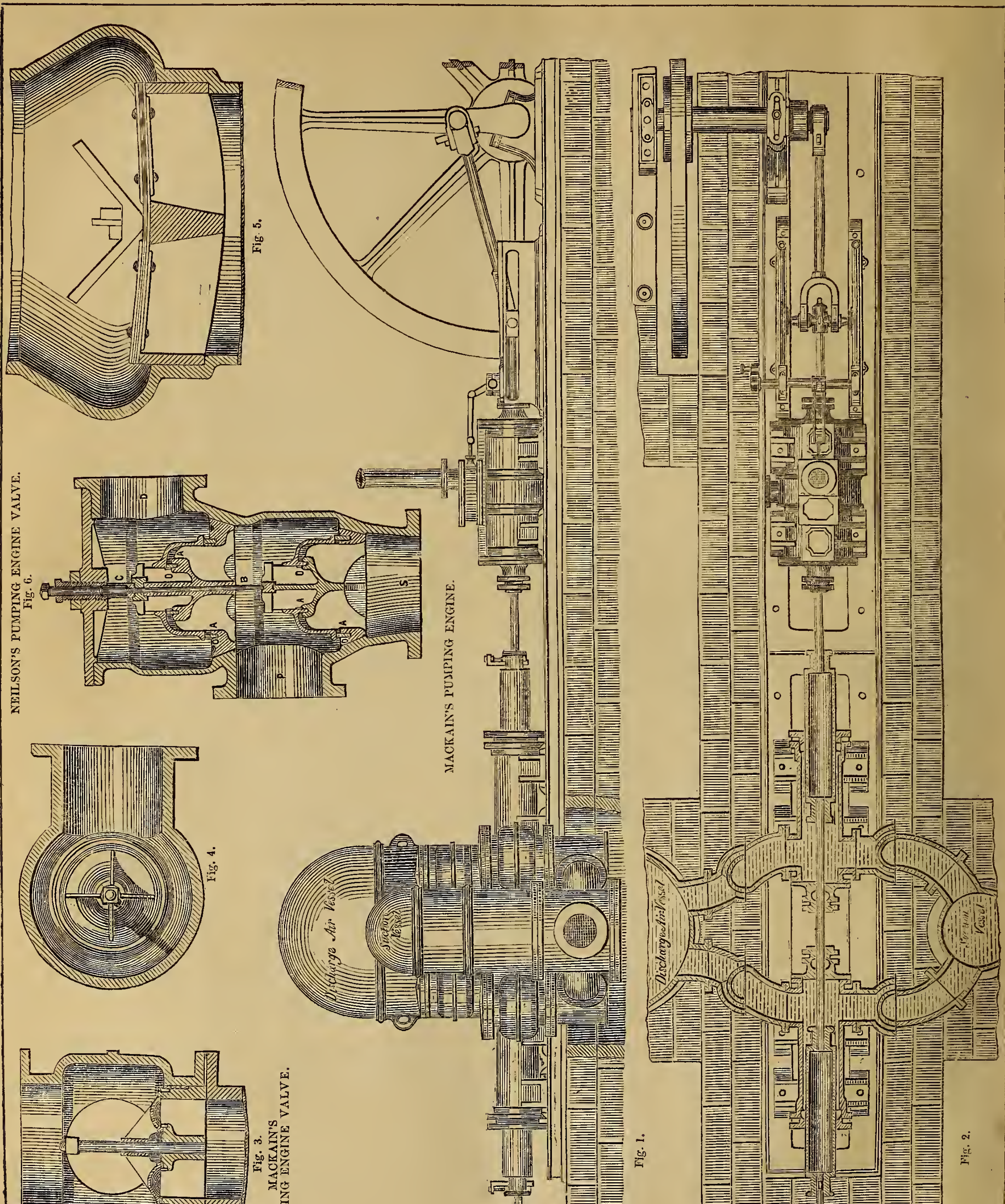


Fig. 5.
NEILSON'S PUMPING ENGINE VALVE.
Fig. 6.
Fig. 4.
Fig. 3.
MACKAIN'S
PUMPING ENGINE VALVE.
MACKAIN'S PUMPING ENGINE.
Discharge Air Vessel
Suction Vessel
Fig. 1.
Discharge Air Vessel
Suction Vessel
Fig. 2.

The water pumped by the engine in use is the surplus beyond the wants of that part of the city termed the low-service district, which the main engines at Dalmarnock raise from the filters on the banks of the Clyde.

This surplus escapes by two overflow pipes, at the height of about 100 ft. above high-water of neap tides, and it is collected in a reservoir of masonry.

The average level of the water in this reservoir is from 5 to 6 ft. below the overflows. From this level, the engine at Drygate raises the water to the further height of from 180 to 200 ft. above the reservoir, or to a total height of from 270 to 300 ft. above low-water. The points of delivery of the water are not of these heights, but it is necessary to force the water under the pressure corresponding to them, in order to overcome the friction in the distribution pipes.

The engine already in use began to work permanently in August, 1855; and, with little intermission, it has continued to work since that time for seven days per week, and about twenty-three hours per day.

Only one of the lower clacks has as yet been changed, as worn out. The two upper valves have been removed, the injury to them having proceeded from defects in the brass of the lids, or valves.

The districts of the city which this engine supplies with water are:—

St. Rollox, and Garngad Road.
The Rottenrow, and houses on the high ground near it.
The upper floors of Blythswood Hill.
Garnet Hill.
Hillhead, and the Great Western road.
Woodside Crescents, and the New West-End Park.

The rapid increase of the population in these important districts, has rendered the construction of an additional engine necessary.

Mr. Mackain said, the engines described had been adopted on account of their simple construction. They required very little repair, and their expense was much less than that of ordinary pumping engines. He thought the smallness of the wear was attributable to the employment of a fly-wheel, by which the working of the valves was better regulated. It was well known that in pumping-engines without fly-wheels, the valves experienced severe shocks from the steam. In answer to an inquiry, Mr. Mackain said, that the pressure on the pump-valves was about 80 lbs. to the in.; that the engine worked at the rate of 25 revolutions per minute; that the pump raised 1,200 gallons of water per minute 200 ft. high; and that the engine cost £1,200.

Mr. Walter Neilson said, he had seen the earlier of the two engines described at work. It was exceedingly simple, compact, and cheap. He thought, however, that a short stroke for pumping-engines was entirely wrong. The longer the stroke was, the better. His firm had recently made pumping-engines with strokes of 8 to 10 and even 12 ft., for 16 to 18 in. pumps; and he should recommend a stroke of 20 ft. where it was attainable. The great aim in constructing pumping-engines was to reduce the shocks occurring at each reversal of the motion of the parts. In an engine with a 5 ft. stroke, this reversal occurs three times as often as in an engine with a 15 ft. stroke, the same quantity of water being lifted in both cases. He would recommend any future pumping-engine like Mr. Mackain's to be made with a 16 ft. instead of a 4 ft. stroke, and he did not think the cost would exceed half as much again as the engine described, whilst it would stand much better. The fly-wheel performed an important duty; it caused the motion of the plunger to gradually increase to a maximum at the centre, and then as gradually decrease towards the end of the stroke. In the common Cornish pumping-engines, on the other hand, the steam lifted a dead-weight throughout the stroke, and then let it suddenly fall. At the same time, the shock was found to be very little in the Cornish engine; but this class of engine was not so suitable for supplying water to towns as for mining operations.

Mr. Mackain quite agreed with Mr. Neilson as to the preference to be given to long-stroked over short-stroked pumping-engines; but the engines he had described were merely for a temporary purpose, and looking forward to their being superseded by works of a more permanent character, he had, as much as possible, studied economy in the construction and working of the present engines.

Mr. Walter Neilson said, he ought to have mentioned that he was aware the present engines were auxiliary engines, and merely temporary. As such, they were the cheapest, and did the greatest amount of work that could be obtained for the outlay.

The President remarked, that the different principles upon which pumping-engines were constructed formed a very important subject for discussion by the Institution. The engine described by Mr. Mackain appeared to be the best that could have been adopted, considering the special circumstances of the case. He had seen the earlier Drygate engine, and could speak highly of it.

[The discussion on this subject was continued at the next meeting.]

ON A PUMPING-ENGINE VALVE.

By Mr. Walter Neilson (of Hyde Park Foundry, Glasgow).

The accompanying woodcut, Fig. 6, is a section of valve-boxes and valves, as made by the writer, for plunger pumps.

The suction opening is marked s; the discharge, d; and the opening to the pump, p.

The valve-seats, a, are, in this case, of cast-iron, and have grooves turned in them to receive hardwood bearing surfaces, o, for the valves to beat upon. The wood is driven in, in short pieces, and afterwards turned up in the usual manner. It will be observed, that the valve-seats are fitted into the chests or boxes with a very great angular bearing, so that, on taking off the valve-chest cover, the valves and seats can at any time be easily lifted out. When put in, they are kept in their places by spindles; a solid one, b, for the under or suction valve; and a tubular one, c, for the upper or discharge valve—these spindles being screwed through the valve-box cover.

The valves, which are made of gun-metal, resemble what is called the double beat or equilibrium class, being indeed designed from the double-beat Cornish steam valves, as made by the writer.

The stroke of the pumps attached to these valves is 33 in.; the diameter of the plungers being 14 in.

The head pressure is from 200 to 300 ft.; and the speed 23·825 strokes per minute. The valves work with remarkable ease, being scarcely heard to fall, and they are free from the concussion generally attending force pumps with any considerable head pressure. The plungers are worked from crank discs on a shaft over the well; this shaft gearing with the crank shaft of the engine. The fly-wheel is upon the pump shaft, which makes rather less than one turn for two of the engine.

With a long stroke, the valves should, perhaps, have a larger opening in the top than is shown in the figure, particularly if there is a great head of delivery, so as to reduce the pressure upon the valve. In such case, more time would be given at the turn of the stroke for the valves to close, as in all cases the valves ought to close before the return stroke of the pump acts upon them.

In continuation of discussion, Mr. Mackain said that the valves in use at the main engines—the cylinders of which were 72 in. in diameter—at Dalmarnock, on the banks of the Clyde, were butterfly valves of 36 in. diameter, formed of leather (hippopotamus hides), having malleable iron plates above and below, rivetted together, as represented in Fig. 3. When the engines were first started, and the demand for water by the city did not require them to be driven at a greater speed than 160 ft. per minute, these valves lasted from six to twelve, and sometimes fifteen months; but the great increase in the demand for water since that time, had required the engines to be worked at the rate of about 280 ft. per minute, and this speed subjected the valves to great concussions, and caused much wear. He had now great difficulty in obtaining iron of sufficient strength to withstand the concussion, without being too heavy. The iron used was Lowmoor plate, ½ in. thick. The valves generally split in two, and thus the leather mounting was lost. This had made them expensive, and he was making some experiments to ascertain the safety and economy of brass valves as a substitute.

In the ordinary pumping engines, the sides of the clack seats were cylindrical, and the valves nearly filled the whole space, so that when the water was forced through them, they had to rise high to afford sufficient area for its passage, and frequently broke the guards used to restrain them. The shock on shutting was also great, being proportioned to the square of the extent of fall of the valve. To remedy this defect, in reconstructing the clack seats, he had enlarged their diameter immediately above the valves, to the extent of about 6 in. beyond the body of the valve seat. This afforded a clear lateral space all round the valve for the escape of the water, as shown in the Figures. The result was, that the valves did not now rise to the guards, and their fall being much lessened, the shock was consequently greatly diminished.

He had tried a lower or suction valve, of the form of Harvey and West's, at the Cranston Hill Works. Its diameter was 20 in., and the weight of the valve was 2 lbs. per in. of area, whilst the height to which the water had to be raised by atmospheric pressure was about 24 ft., thus making, with the weight of the valve, a virtual column of nearly 29 ft. of water. This was too much for the velocity of the piston; the water did not flow with rapidity enough to fill the pump barrel, and the engine struck heavily on the return stroke. This compelled him to abandon this kind of valve after three or four hours' use.

In reply to questions from Mr. Dixon and Mr. Elder, Mr. Mackain said, that the reservoir from which the Drygate engine pumped water was about 10 ft. below the pumps, and the average height of the surface of the water about 5 or 6 ft. more. The water pumped by the six main engines at the Glasgow Waterworks, Dalmarnock, was drawn from the filters on the opposite bank of the river by suction pipes placed under the Clyde. The water was drawn up through the suction valves or lower clacks, and fell into the pump barrel above the piston or plunger. The vacuum required was about 18 ft. in ordinary circumstances, but when the filters were drained, and the Clyde low, the vacuum was

greater. The pump plunger, when at the top of its stroke, was about 4 ft. above the suction valve.

Mr. Elder, recurring to the question before the previous meeting, regarding long and short strokes for pumps, said it was very important. Did not the question resolve itself into one of capacity? If two pumps were of the same capacity, say one twice the length of the other, and the other twice the transverse area of the first, and they made the same number of strokes per minute, the action on valves would be precisely the same in both cases, notwithstanding the difference in the length of stroke.

Mr. Neilson said, that whilst he gave due weight to the preceding observation, he should not give up the notion of "long strokes," particularly in pumps used for mining purposes, where they were limited as to the diameter of the pump. An enlarged diameter also involved an enlarged plunger, which would increase the difficulties connected with the gland, whilst there would also be more friction with the larger plunger. These objections were of much importance in connection with mine pumps, more of which were at work, perhaps, than any other. He should certainly adopt as long a stroke as possible for such pumps.

Mr. Bell remarked, that it would be useful to have a record of the various proportions of transverse area to stroke that had been adopted, with the results obtained in each case.

Mr. D. More being asked his experience of the friction of glands and collars, and of large and small plungers, said that he had, some time back, had something to do with a pump, 14 in. diameter, 3 ft. stroke, for pumping very dirty water, when they were very much bothered with valves resembling that in Fig. 6. The pump barrel eventually burst, and they substituted three pumps, 10 in. diameter, 2 ft. 6 in. stroke, with valves like that shown in Figs. 1 and 2, and they had since had no trouble whatever with them, beyond putting in a new bucket once. These pumps were worked by triple cranks, and had been seven years in use.

Mr. Elder stated that he had recently made a pump 4 ft. in diameter, with a stroke of 14 in., and had found it to act very well. He was to a certain extent compelled, by the peculiarities of the case, to adopt this proportion, but it had succeeded so well that he should be inclined to adopt similar proportions in future, when circumstances admitted of it.

Mr. Ferguson thought some mechanical difficulties would attend the use of such proportions. In the case of plunger pumps, the gland would present a very serious difficulty.

NOTES ON AMERICAN LOCOMOTIVE ENGINES.*

By Mr. Walter Neilson (of Hyde-park Foundry, Glasgow).

(Illustrated by Plate No. cxxx.)

The fact that this country first gave birth to the railway and its engine, and brought this great system of locomotion to its present state of perfection, is apt to make us regard the like work of our followers with too much indifference. No doubt the Americans have been accustomed to look to this country for all improvements connected with railroads and their attendant machines; but when we look at the United States, with their 21,440 miles of railroad against 8,054 miles in this country, we may predict that the time is not far distant when we may look to our friends across the Atlantic with the expectation of learning something from them even in railway engineering.

In the American locomotive engine as at present constructed, we have a gay, jaunty-looking vehicle—very different from the sombre business-like machine of the old country. The extraordinary amount of bright brass and bright painted ornamentation one is scarcely prepared for; yet the care with which all this gaudy decoration is kept clean, gains our admiration of and interest in the machine, the effect being somewhat favoured by a generally clear and dry climate.

The ordinary form of locomotive engine used all over the States has driving wheels before and behind the fire-box, coupled together; the fore part of the engine being carried on a swivel four-wheeled truck or boggie. It is worthy of remark that in America they seem, with a sort of common assent, to have agreed as to the best form of engine suitable for their purposes, whilst we, in this country, if we may judge from the variety of engines to be seen, would appear not yet to have arrived at this step towards perfection. The old "Bury" engine seems to be the type from which the American engine has come, as the combined truss-form of frame used in that engine is still closely adhered to in the United States.

The engines generally used for both goods and passengers have 15 in. to 16 in. cylinders, and eight wheels; coupled driving wheels of 5 ft. to 5 ft. 6 in. diameter, with truck wheels of 22 in. diameter. The driving wheels are placed close to each other, one pair before and the other close behind the fire-box, the springs being connected by compensating levers.

* Paper read at the Institution of Engineers in Scotland.

The truck wheels, in the most cheaply-constructed engines for narrow gauges, are set about 3 to 3½ ft. from centre to centre of the axles; but there seems to be a feeling in favour of setting these wheels wider, for safety, say up to 5 or 6 ft. from centre to centre of the axles. Compensating levers are sometimes put between the truck springs. This truck, with its framing, is almost the only thing about these engines in which much variety in form or construction is seen. They generally have only inside bearings, but many have both inside and outside bearings, from 3½ to 4½ in. in diameter. The framing of the trucks is of wrought iron —the simplest form consisting of two flat side bars, the ends of which are made to clasp the bushes of the axle bearing, whilst the centre part is made up of two plates rivetted above and under the side bars, with thimbles between them. A large inverted spring at each side, with its ends resting above the axle bearings, and the centre under the engine framing, bears the weight of the engine. This arrangement, however, does not admit of one wheel rising without raising the whole frame. The most improved truck frames have the action of the wheels independent of each other, the axle bearings running in ordinary sliding axle boxes, with a spring to each bearing or wheel. Many of these trucks exhibit ingenious applications of the truss-frame principle, adopted in order to obtain the greatest strength with the least weight. The bearing weight of the engine rests on the side frames of the truck, and not in the centre, as is the case with some truck engines made in this country. Safety chains from the engine are attached to each corner of the truck, to prevent its dropping down in the event of an axle breaking or a wheel coming off.

The truck wheels are cast solid, without arms, and are chilled on the rims. The driving-wheels are also of cast iron, and remarkably light, being hooped with Bowling or Lowmoor tyres. Great care is taken, in making these wheels, with the proper thickness of the parts, the quality of the iron, and the manner of casting them. The iron of this country—the Scotch iron—so much of which is imported into the States, is quite unfit for wheel-making. In Messrs. Whitney's wheel factory at Philadelphia, a handsomely-built and well-arranged establishment, the casting house was about 460 ft. long by 60 ft. wide, lofty, and covered with a neat iron roof. Four large cupolas or melting furnaces were arranged in the centre, and at the end four large annealing furnaces. A main road with rails ran down the centre of the building, and the floor on each side was covered with wheel moulding boxes, whilst light-framed four-wheeled trucks, with high light wheels, moved over the boxes on rails, spanning the whole width of the moulding floor on each side, carrying a jib-crane at each end. A large ladle on a frame carriage, mounted with pouring gear, and capable of containing 15 tons of melted metal, moved down the rails of the centre road. Small ladles, suspended from the cranes above mentioned, and containing only as much metal as would cast one wheel, received the iron from the large ladle. As soon as the wheels were cast, they were lifted and carried down to the annealing furnace by these same truck cranes, and piled up there, a cast-iron ring, about 4 in. deep, being put between each wheel. The top of the furnace was on a level with the floor, and having been previously heated to a clear red heat, as soon as it was filled, the covers were put on and luted, the dampers closed, and the fire-door and ash-pit shut up; the whole was then left to cool. At the end of the fourth day the wheels were taken out, carefully examined, and cleaned. The car and truck wheels are cast in iron chills. On examining the pieces of the rims of wheels made there, it will be observed that the effect of the chilling penetrates about 5-8ths of an inch into the iron. Four specimens were exhibited, two showing the section of car wheels annealed, or cooled slowly in four days, and two showing the section of wheel cast in chills in the ordinary manner without annealing. The effect of the chilling is shown in Fig. 2, Plate 130, which represents the broken surface of a wheel rim. In chilling wheels made of Scotch iron, the annealing is seldom observable more than 1-8th of an inch under the skin, showing that there is some very remarkable difference between the two kinds of iron in this respect.

The boilers for locomotives are made very similar to those of British engines, except in the connection between the raised outer fire-box and the barrel, which consists of a straight taper instead of the square, formed by flanching or angle iron, as will be seen on referring to Plate 130, which is reduced from one of the numerous drawings exhibited when the Paper was read.

The writer was much pleased with the excellent boiler work he saw in the States, both for marine and locomotive purposes. At the works of Messrs. Winans and Co., Philadelphia, he examined locomotive boilers drawn together for rivetting, and every hole appeared as if it had been bored and carefully rimelled. All the plates were marked for punching by a centre punch only, and the punches of the machine were turned in the lathe, leaving a small projecting pin or centre point, and no hole was punched by the machine until this point was felt in the centre punch mark on the plate.

In ordinary boilers for wood burning the fire-box and tubes are of iron; but those of the best construction have a copper fire-box tube plate, and about No. 14 W. G. copper tubes. The writer was told the brass tubes used in this country would not do for wood-burning engines,

but could not get a satisfactory reason why. In some coal-burning engines the fire-box is made of copper, a few inches above the top of the fire, the other part being iron.

In wood-burning engines, the blast-pipe for a 15-in. cylinder is sometimes reduced to 1¾ in. diameter, and for a 16-in. cylinder to 2 in. diameter. (In this country a 16-in. cylinder has a blast-pipe opening as large as 4 in. diameter.) Considerable obstruction to the blast is caused by the spark catcher over the chimney. This, to our eye rather unsightly appendage, is necessary to prevent the sparks from the wood being thrown out, to the great danger of fields of grain and forests during the hot season, and is simply a cap of light cast iron—like an inverted cone—set above the chimney, the steam striking against it, and being turned back into the outer casing, where it deposits the sparks or burning wood. As a further security, a piece of wire cloth is set over the whole.

There are a number of schemes and patents for spark catchers, having angular blades and spiral channels in which the sparks are arrested, but the kind described is that most in use.

The smoke-box is generally formed by a continuation of the barrel of the boiler—the smoke-box door, of an ornamental form, generally of cast iron, being put on with bolts, there being no ashes deposited, and the dust from the wood being carried into the spark catcher, whence it is withdrawn by a small door at the bottom.

The wood used in the engines is split into billets, from 2 to 3 ft. long, which are thrown into the fire-box by hand. Were it not for the great labour of constantly feeding the fire, wood makes a very cleanly and pleasant fuel for use. It is sold and reckoned by the "cord"—about 120 cubic ft. piled, or 6,000 lbs. weight. Passenger engines use about a "cord" of pine wood per 40 to 45 miles; or of oak per 50 miles. The American railroads generally pass through forests somewhere in their extent, and when the settlers clear the ground they split the timber and build it up alongside the track. The railway people lift it, and haul it to their stores, where it is sawn into lengths and stacked. The settlers get from 2 dols. to 3 dols. per cord for it, if at all near towns. About New York it cost, when the writer was there, from 5 dols. to 7 dols. or more, in the tender.

In consequence of the high price of wood, considerable attention is now being turned towards engines constructed to use the coal of the country. It is proposed to notice these engines in a future Paper on the subject of coal-burning engines; but it may be remarked here, that in America, with such great coal fields, this question is about as important as it is in this country.

It will be observed that the American engines carry a large bell, which is used to give a signal of danger to the public, and all parties *not* connected with the railroad. It is constantly kept ringing when the engine moves along the streets in towns, or crosses roads, the driver being liable to a heavy fine should he fail to ring his bell on such occasions. The whistle is used to signal to employées on the road.

The sand-box is placed on the top of the boiler, within an ornamented casing, similar to the steam-chest, and a pipe on each side leads the sand down to the rails.

The cab on the foot-plate is quite peculiar to American engines, and is a source of great comfort to the men. It is generally found very neat and clean within, with a cushioned seat on each side. Egress to the platform plates is obtained by small doors at the front.

The head lamp is a very clumsy affair, and does not give so much light as those of this country, in consequence of a simple reflector and plain glass front being used instead of lenses of glass.

The cow-catchers in front, required to keep off cattle where the tracks are unfenced, are made of either wood or iron, and of forms shown in the drawings. These machines have been known to save lives, by knocking people off the track, instead of, as with our engines, knocking them down among the wheels.

As will be observed, from the examples given of American engines in the illustrations before the meeting, the slide-valve chest is usually outside above the cylinder, the motion to the valves being communicated through a rocking shaft; and, although most of the modern engines have the English link motion, many makers adhere to the old favourite American expansion system of one valve sliding on the back of the other, receiving its motion from a third eccentric, and all having the old gab or V connection. The amount of expansion is regulated by moving the end of the valve connecting rod in an arc, which forms the arm on the rocking shaft.

In many of the freight or mineral engines, the old hand gear is still used, and preferred for convenience in shunting, and starting on heavy gradients, or in snow storms.

Cast iron is used for the eccentric hoops, piston-rod clutches, arms of the rocking shafts, and other parts, which are usually, but, as the writer thinks, unnecessarily made of wrought iron or brass in this country. The number of bolts used to fix those parts which required to be examined, or occasionally taken to pieces, is, in the American engine, reduced to a minimum. A gland with one screw fixes the two feed-pump valve chest covers, four bolts the slide valve box cover, and so on.

Gauge glasses are not used on the boilers, and it would appear, rather curiously, those tried have always broken so often that they have been abandoned altogether, and three gauge-cocks used instead.

Cast-iron chilled tyres or hoops have recently been introduced on freight engines where the wheels are not large. They are made about 3 in. thick, and are fixed on the wheels by a number of keys sunk in the rim of the wheel, and slightly also in the tyre, having heads at one end and nuts at the other, which, when screwed up, bear both on the wheel and tyre, preventing it from slipping off.

The large eight coupled wheeled freight engine (represented in Fig. 1, Plate 130), by Winans, of Baltimore, was made originally with cast-iron chilled wheels; but it being found troublesome and expensive to replace them, cast-iron tyres were successfully substituted, and are said to be much more desirable than wrought iron ones. This engine is peculiar in its construction and appearance. The grate-bar area is unusually large. The anthracite coal is put into the furnace by the hoppers, A, B, which are filled, the door, C, put down, and the slide doors, S, drawn, preventing the rush of cold air into the fire-box which takes place when firing in the usual mode. There are doors also at the end of the fire-box, by which the stoker can arrange and clean his fire. The valves are actuated by eccentric cams, and the old hand gear levers are used as before mentioned. The writer saw a great number of these engines at work on the Baltimore and Ohio railroad. The locomotive superintendent stated that they gave much satisfaction. In Messrs. Winans' factory several of these engines were being made, but with the addition of a truck in front. This engine weighs above 32 tons; cylinders, 19 in. diameter, 22 in. stroke; wheels, 3 ft. 9 in. diameter; and it works over the summit of the Alleghany mountains, having 500 ft. rise in a mile, taking, however, only one waggon of about 15½ tons weight. This part of the road is now tunnelled, but they still work 17 miles with 117 ft. rise to the mile, and in many places there is 85 ft. rise to the mile. The usual load is twenty-two waggons, equal to 220 tons freight. The working speed does not exceed 12 miles an hour.

The American eight-wheeled truck engine is a beautifully balanced and steady machine, remarkably easy on a bad road, and much safer than an English engine under similar circumstances.

From the reported accidents on American railroads it would appear that these engines keep the track well at the speed they travel, which seldom, if ever, exceeds 40 miles an hour, the average running speeds of the express trains being generally from 30 to 35 miles, and that of freight trains about 15 miles an hour.

The great objection, and perhaps the only one to the American engine, is the difficulty of obtaining sufficient weight upon the driving wheels. With a 25-ton engine, seldom more than 15 tons can be got on the drivers, even by keeping the truck well forward.

There are several designs of freight engines used; those before the meeting give an idea of their leading peculiarities.

In Baldwin and Co.'s eight-wheeled coupled engine four wheels are in a swivel truck, which arrangement, with spherical bearings in the couplings, the makers say, gives freedom on curves. This, however, appears doubtful. The only available relief seems to be in running the middle wheels without flanches, as done in Rogers, Ketchum, and Grosvenor's engine, and as is indeed the practice with the ordinary eight-wheeled engines.

An American locomotive is represented in Plate 130, selected from the numerous drawings exhibited at the meeting.

An arrangement of engine on the American plan, by Neilson and Co., of Glasgow, is represented in Plate 130, Fig. 2, where the spring compensating levers are distinctly shown. This, and one slightly different, were made for British America, and are, perhaps, the first really American locomotive engines made in this country.

Mr. Neilson handed round some specimens of chilled cast-iron wheel rims, showing the penetration of the chilling action quite 5-8ths of an inch from the surface, as is represented in Fig. 7, Plate 130. He said, the American cast-iron wheels were as light in appearance as wrought-iron wheels.

The President inquired, if Acadian iron was ever used in making them, and said that some specimens of this iron exhibited a remarkable degree of toughness. He had seen pieces of Acadian cast iron twisted about in a way which common cast iron would not bear. The toughness might, perhaps, be attributable to the absence of sulphur.

Mr. J. R. Napier said, that when he was in Boston, some eight or nine years ago, he saw some cast-iron guns made for the American navy, the metal of which was very like Stirling's toughened cast metal. He also at the same time observed the fine quality of the iron used in the construction of boilers. The boilers were made with little or no angle iron, the edges being all flanged over.

The President believed the use of angle iron in the construction of boilers to be often objectionable. Boilers had been known to give way at the angle iron.

Mr. P. Stirling thought angle iron would be much stronger than flanged plates.

Mr. Neilson said, that in the States the holes in the tube plates of marine boilers were flanged inwards to receive tubes as small as 5 in. diameter, through which they were rivetted. In American wood-burning locomotives the labour of firing was very great. It was the constant employment of the fireman to pitch the wood into the fire-box.

The President had little doubt but that British cast iron could be made of as good quality as any other, if the proper means of working it were only known. From Professor Barlow's late experiments on beams, it appeared that the strength of the skin of bars of British cast iron was about two-and-a-half times greater than that of the interior. In the Acadian iron there was a greater uniformity in the strength of the skin and of the internal parts.

In reply to inquiries, Mr. Neilson said, the pressure used in American locomotives was about 80 lbs. per square inch. He could get no satisfactory replies to his inquiries as to the durability of the American locomotives, and the work or mileage done at a given cost. Captain Galton gave a general statement to the effect that there is 35 per cent. in favour of the durability of British locomotives. In the New England States, however, they were equal to British engines. In the south it was common to use cast-iron rocking shafts, chilled cast wheels, single springs acting on two axle boxes, and similar things, which reduced the total cost, and rendered comparison difficult.

The President inquired, whether any comparison had been made of the resistances of American and British engines, and how the friction was affected by the truck with its small wheels in front?

Mr. Neilson said, the swivelling of the truck avoided the friction of the flanges on the rails, but from the smallness of the wheels the friction of the axles would be increased; on the whole, however, he thought the American locomotives had less frictional resistance than ours. The axle-journals of the 22-in. bogie wheels were $3\frac{1}{2}$ to 4 in. diameter, whilst the axle-journals of our leading trailing wheels were about $4\frac{1}{2}$ in. in diameter. This gave the bogie axle-journal a very much greater surface velocity, but there was only half the weight bearing upon it.

Mr. Tait thought the small wheels were objectionable, as they would sink into the concavity formed in the rail by the weight of the locomotive, and be constantly moving up a never-ending incline, the effect of which would be worse on the smaller wheel. He thought that many of the American locomotives, presenting a confused mass of stripes of paint and brass, were the flimsiest pieces of mechanism in existence; and that for work and durability they were not half the worth of ours. He must, however, except the boilers from the charge of flimsiness. The workmanship of these was very excellent. They used larger and more ductile plates than we got here. He had in New York seen boiler plates 14 ft. by 7 ft. broad, intended for the upper part of the boiler.

Mr. Napier observed, that the Americans covered their boilers with a kind of Russian iron-like copper, and possessing a beautiful skin.

Mr. Neilson said, he envied the Americans the use of this iron, which they employed in great quantities. Its surface was of a blue colour, like zinc. It never rusted, but always remained clean and pretty. It was very expensive, but the manner of its manufacture was still a secret. He had heard of two acute Yankees, living in Siberia for several years, endeavouring to find out the process, but in vain.

ON THE STABILITY OF LOCOMOTIVES.*

By Mr. J. G. Lawrie (Glasgow).

The instability of locomotives arises from two causes—the internal disturbing action of the engine itself, and the unevenness of the permanent way. The control of these elements of instability is materially affected by the disposition of the axle bearings. These bearings in some engines are all of them outside the wheels; in some they are all inside; while in others, either the leading or the trailing axle, or both, have their bearings outside, and the driving axle inside.

A little reflection makes it appear that the merits of the several arrangements of the axle bearings are developed on considering the two forms, the one shown in Fig. 4, Plate 130, in which the leading axle alone has outside bearings; and the other shown in Fig. 5, in which the trailing axle alone has outside bearings.

The internal disturbing action of the engine itself arises chiefly from the angular action of the connecting rods above and below a horizontal line, and from the momentum of the reciprocating parts. The disturbance from unevenness of the permanent way is caused by the curves, and by the state of repair in which the permanent way is. When an engine is well balanced, the instability or oscillation arising from the action of the connecting rods, and from the momentum of the reciprocating parts, is nearly removed, or at all events so nearly removed as to leave the disturbing action from unevenness of the road—of an importance by much the most material. The instability caused by unevenness of road arises either from inequality in the top and side surface of the rails, such as unfair butt joints, or from the difference of level of the rails in a curve, together with the difference in the length of the rails on the outside and inside of a curve. Of all the causes of instability, however, which an engine in good repair encounters on a line also in good order, that received when travelling at a high speed in a curve is the most important.

When an engine is in motion round a curve in the direction of the arrows, A, in Figs. 4 and 5, all the parts of the engine resting upon the springs, tend, in consequence of their momentum, to move off the line in the direction of a tangent to the curve, whilst the wheels and axles are forced by the rails to follow the curve. Thus the parts of an engine upon which the springs bear are forced to move in a direction forming some angle with the direction in which the parts supported by the springs tend to move, and that engine is the most stable which receives from the springs the greatest assistance in maintaining the entire structure in the shape and position it occupies when at rest. Suppose the arrows, A, represent the direction of a curve in a railway, and the arrows, B, the direction of a tangent to that curve, the question arises whether the arrangement of axle bearings in Fig. 4, or that in Fig. 5, contributes most to maintain the several parts of the engine in the position which they occupy when the engine is at rest. At C D are the bearings upon which the springs rest on the leading axle, and it is plain enough, with but little consideration, that the further apart these bearings are, the more effectually do the springs control the dislocation of the engine, and therefore the more stable is the locomotive. At E F are the spring bearings on the trailing axle, and it is equally apparent that the distance asunder of these bearings, though not by any means immaterial, is of very inferior importance in the stability of the engine to the width of the bearings on the leading axle.

It thus appears that wide bearings on the leading axle are of the highest importance in controlling the particular disturbance in the stability arising from a curve, and this is the most important element of instability; but the width of these bearings is of equal importance in controlling every other cause of instability. It has been contended, against outside leading axle bearings, that when the engine, so constructed as in Fig. 4, travels over hollows in the permanent way, violent shocks are given by the springs acting with so much leverage from the centre of the engine. This argument, however, is of no moment, because those lines on which hollows so precipitate exist are unfit for high speed; and the very fact of this argument being used against outside bearings, proves the efficacy of the arrangement in maintaining the stability of the engine.

Locomotives constructed with outside cylinders, and leading axles having outside bearings, possess the principal features of Locke's Crewe engine, and the admirable efficiency of that engine in these two particulars seems to give it the highest position among existing locomotives.

I have stated, and experience has repeatedly proved, that in an engine properly balanced, no instability exists, which is caused by the angular action of the connecting rod, or by the momentum of the reciprocating parts; but those most familiar with locomotives know best that engines, generally, are far from being so carefully adjusted. No engineer now considers that he has altogether finished the construction of a stationary or marine engine until he has proved its correctness by the indicator, and to a much greater extent should the balancing of a locomotive be deemed a part of its construction. In those instances in which engines have been balanced with accuracy, the means employed have been of a temporary and somewhat imperfect description, but a suitable machine for regular use would not be by any means an expensive one. Fig. 6 represents one form in which it might be constructed. Two beams, A B, are carried by four rods, E, F, G, H, and suspended from a pivot, K. At L M are one or two wheels, as the case may be, upon which the driving wheels of the engine revolve, and friction straps, N, O, are provided for the purpose of grasping the driving wheels with an amount of force such that full steam may be applied to the engine. The point of suspension at K, is capable of being shifted so as to balance the entire weight. The wheels at L are capable of being shifted to suit different engines. Such a machine would be by no means cumbrous or expensive, and would serve the purpose of balancing the moving parts of the engine much more effectually than can be done by any of the numerous modes of calculation extant. If to this machine another be added, for the purpose of loading the driving wheels equally in the case of coupled engines, locomotives would be balanced with an accuracy unknown in present practice.

Considering that the work performed on our several railways is similar, and in the case of all our principal ones the same, the variety of locomotives in use is much more apparent than advantageous. To the possessor of railway property this is a matter of no indifferent character, because upon the locomotive depends, to a large extent, the amount of his return. Yet all the information the railway proprietor possesses regarding his motive power is, that the engine employed on his own line is the one deemed by his own superintendent to be the best, and that this same engine is deemed by all other locomotive superintendents, or,

* Paper read at the Institution of Engineers in Scotland.

at all events, by nine out of every ten, as very inferior indeed. This is surely not the condition in which our railway motive-power should stand.

I have already described a machine which is, in some measure, adapted to perfect the construction of the locomotive in certain respects, and I shall now describe an instrument which I confidently believe is fitted to bring about its more perfect construction, not only in those respects, but in others of vast importance, and capable also of leading to improvements in points in which it is not yet known that improvement is possible.

In 1829, when the competition with locomotives took place on the Liverpool and Manchester Railway, results were obtained wholly unanticipated, and a start forward was given to locomotive engineering which hastened the advancement of railways to an extent that cannot be overestimated.

In agricultural engineering, what has been the result of repeated competition? The result has been, that in no branch of the mechanical arts have strides so large or more successful been made.

In Lancashire, at the present moment, through the operation of the association formed for the prevention of steam boiler explosions, and for effecting economy in the raising and use of steam, a constant and accurate comparison is being made of upwards of 600 steam engines, and beyond a doubt one result of this association, perhaps the most important result, will be, great improvement in the machinery which falls within its range. It is impossible that the accurate observations and tabulated records of that association can fail to raise, at all events, the inferior engines to the standard of the best, but its tendency also is to raise the best to a still higher standard.

In all machinery, comparisons ought to be made. In most kinds of machinery, comparisons can be successfully made; but in no machinery can they be made more fully, more easily, and with results more important, than in locomotives.

The instrument, therefore, which I anticipate is capable of leading to results so beneficial in locomotives, is the establishment of competitive trials, with premiums of considerable amount, open to every engineer who chooses to enter the lists. Such competitions would remove the contention of debatable ground, would sift and perfect all existing constructions of engines, and would bring forward improvements that are at present unthought of.

The benefits of these competitions would be reaped by every railway company in the kingdom. Manufacturing engineers also would share in them; they would receive instruction, and would derive employment from the demand for the improved form of engine. Indeed, from additional employment, nothing would more conduce to the immediate profit of manufacturing engineers, as a body, than the invention of an improved construction.

An institution such as this which I now address—possessing, in its members, all the mechanical talent and status of the Clyde, or I may say of Scotland, if that comprehends more—is well fitted to carry forward such a measure as I have suggested, and in return would derive a dignity not unworthy of its aim and emulation.

Sources from which the funds necessary for this object would be derived are apparent enough, and in all probability very large premiums could be offered, which, together with the high position of being successful competitors, would afford inducements sufficiently tempting to arouse from indifference the most distinguished of our engineers.

In every path of human pursuit, in every art and in every science, no motive to exertion has yet been discovered so powerful as rivalry, and for the reason that the action of that motive is measured by the principle the strongest in human nature—ambition.

Mr. Lawrie said, that his views respecting the benefit of outside bearings on the leading wheels were corroborated in a rudimentary way by experimentally placing oneself horizontally, so as to rest on the toes, and on the elbows or arms, when it would be felt that in proportion to the distance asunder of the elbows, was the resistance to a capsize on a push being given forward and laterally, at an angle of say 45°, whilst increasing the width apart of the toes added comparatively little to that resistance.

Mr. P. Stirling preferred that all the bearings should be inside, and did not agree with Mr. Lawrie that outside bearings would increase the stability. The stability depended on the width of base, which, in the locomotive, was 4 ft. 8½ in., the guage of the wheels; the weight above should be kept as much within this base as possible; and the lateral spreading of the weight consequent on the use of outside bearings would be injurious, rather than beneficial.

Mr. Lawrie argued, that if Mr. Stirling's reasoning were correct, it would be best to put the bearings close together, or to use a single long one at the middle of the axle; but this arrangement would obviously involve great instability.

Mr. Allan said, it was usual to suspend locomotives by chains 30 in. long at the four corners, for the purpose of testing and balancing them. Without balance weights there would, generally, be a slight oscillation, such as would describe an oval 1¼ to 1½ in. long, on a stationary card: but when the balance weights were applied, the locomotive was perfectly steady, describing an oval not more than 1-16ths in. long, when working at a speed corresponding to 50 miles per hour.

Mr. Lawrie said that, according to his plan, the locomotive was suspended from a single point, instead of at the four corners; he did not, however, so much bring it forward as new, but because he thought its usefulness was not sufficiently recognised.

Mr. Neilson doubted whether the proposed competition would lead to any result; he thought engineers would not be got to agree to it.

SHIPBUILDING ON THE CLYDE.

The screw-steamer *Bremen*, built and engined by Messrs. Caird and Co., of Greenock, for the Norddeutscher Lloyd's, of Bremen, was tried on the 25th May, on the Clyde. The vessel ran the distance of 13⅗ nautical miles (from Clough to Cumbrae Lighthouse) down in 58 minutes and up in 66 minutes, which is equal to an average speed of 13·15 knots per hour. The draught of water, with 1,450 tons of coal and iron on board, was at the same time 18 ft. 6 in., whilst the consumption of coal did not exceed the very small quantity of 4,200 lbs. per hour. At the above speed, the indicated H.P. of the engines was 1,624, the consumption of coal per indicated H.P. being thus only 2·58 lbs., the engines making 53 revolutions per minute.

The dimensions of the vessel are:—

Length between perpendiculars	318	ft.
Breadth of beam	40	,,
Depth of hold	26	,,
Displacement at this draft	3,440	tons.

The vessel is fitted with an elegant first-class cabin and berths for officers and crew on the spar-deck, and a second-class cabin and steerage on the main deck.

The engines consist of two inverted direct-acting cylinders of 90 in. diameter and 3 ft. 6 in. stroke, working expansively to a very high degree. This vessel, as well as the *New York*, as sister ship to the *Bremen*, which is being constructed, is intended for the trade between Bremen and New York.

HYDRAULIC SHEARING PRESS.

At a recent meeting of the Institution of Mechanical Engineers at Birmingham, a paper was read by Mr. Little, describing an Improved Hydraulic Shearing Press, designed by Mr. Eastwood, of which the woodcuts given below are illustrations.

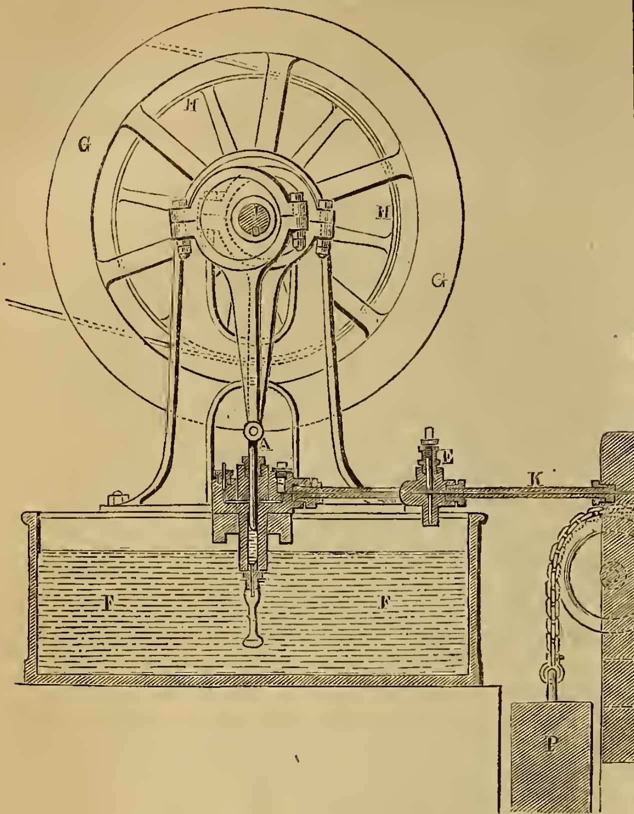
In the manufacture of bars or forgings from scrap iron, one of the chief difficulties to be overcome is the cutting up of heavy scrap of large section, such as railway tyres, axles, engine frames, rails, ship's knees, &c., into pieces sufficiently small for the furnace, without their having to be heated in a furnace or smith's fire before they can be safely cut up by ordinary shears, such an operation involving a great loss of fuel, time, and labour, and consequently making a large item in the cost of manufacture. Several machines are at present in use for shearing scrap, but they are found to have some disadvantages, either from too great first cost, weight, expensive foundations, liability to get out of order from the wear and tear of their working parts, or from their liability to breakage from improper management. This is frequently the case with the common lever shears, which travel so rapidly that there is barely time to place a large piece of iron near enough to the fulcrum before the shear descends, and from the angular position of its cutting edge at the time forces the bar to the extremity of the cutters, sometimes breaking the shears, and not unfrequently injuring the attendant. This is most liable to occur when the iron is of a rounded section, or when it is painted or greasy. Another difficulty arises from there being no means of limiting or measuring the power of the ordinary machines when driven by cranks, cams, or eccentrics; and in case of accident the momentum of the fly-wheel prevents the machinery stopping suddenly; and if it is desired to strengthen the machine, this can be done only by a great increase of weight, necessarily requiring much more power for driving the machine.

Most of these difficulties have been overcome by the simplicity and peculiar construction of Mr. Eastwood's Hydraulic Shearing Press, which is shown in Figs. 1 and 2. Fig. 1 is a longitudinal section of the machine, and Fig. 2 a plan. This machine is so strong and self-contained that there is little or no risk of breakage, as in the ordinary machines, and large and unshapely pieces of iron can be cut up without in the least endangering the safety of the man employed to work the shears, since they are comparatively at rest during the whole operation, and the attendant has them so completely under control by means of a stop-cock, that they can be stopped instantaneously when required at any part of the stroke.

The two pumps, A A, are each 7-8ths in. in diameter, having 3 in. stroke, and the press ram, B, 9¼ in. diameter, with a travel of 6 in., this being a convenient size for shearing such scrap as has been referred to. The machine stands 2 ft. 6 in. above the ground, and occupies a space of 11 ft. 6 in. by 2 ft. 6 in., or about 30 sq. ft., this space including standing room for the pumps. The cylinder, C, and shears, D, are fixed horizontally, so that no foundation is required; and if thought desirable, the machine can be placed on wheels, so as to be readily moved from one part of the works to another. The press being provided with a safety valve, absolute safety against overstrain is secured. In consequence of the shears being so little raised above the ground a tyre can be

rolled alongside the machine, and any part of its circumference dropped between the cutters, D; the stop-cock, E, from the pumps is then opened by the boy in charge, and the tyre can be cut up at the rate of six pieces per minute.

The pumps, A A, are fixed on the top of the tank, F, and are worked by eccentrics, which, together with the fly-wheel, G, and fast and loose pulleys, H, communicating by means of a strap with any prime mover, are fixed on to the horizontal shaft, I, running in bearings on the upright frames bolted down to flanges cast on the sides of the tank. The pumps are fitted with a safety-valve and clack-valve, and are connected with the press by pipes, K, through which the water is forced into the cylinder, C, thus forcing the ram, B, having a cutter or shear, D, firmly secured to its prolonged end, against the bar of iron inserted between the moving and fixed shears, and cutting it through. The part, L, of the ram passing between the plates and jaws, M, is square, and kept in its proper position by guide blocks let into recesses cast in the jaw pieces. The stationary shear, D, is bolted to an upright block, N, forming part of the same casting as the cylinder, jaws, and bed. A cross-bar, O, secured to the ram by screws, has a chain connected to each of its ends, passing over two pulleys, and carrying a weight, P, for the purpose of bringing the moveable cutter and ram back, when communication between the pumps and cylinder is cut off by means of the stop-cock. For working the machine, all that is required is to start the pumps by throwing the strap on to the fast pulley, and the motion of the cutter can be regulated or stopped instantaneously by unscrewing the stop-cock, E.



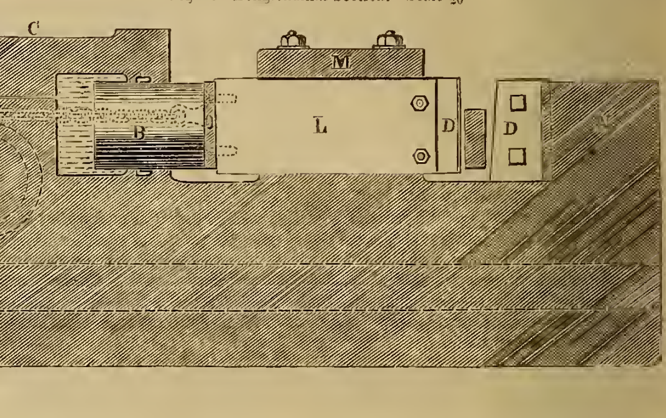


Fig. 1.—Longitudinal Section.—Scale $\frac{1}{20}$.

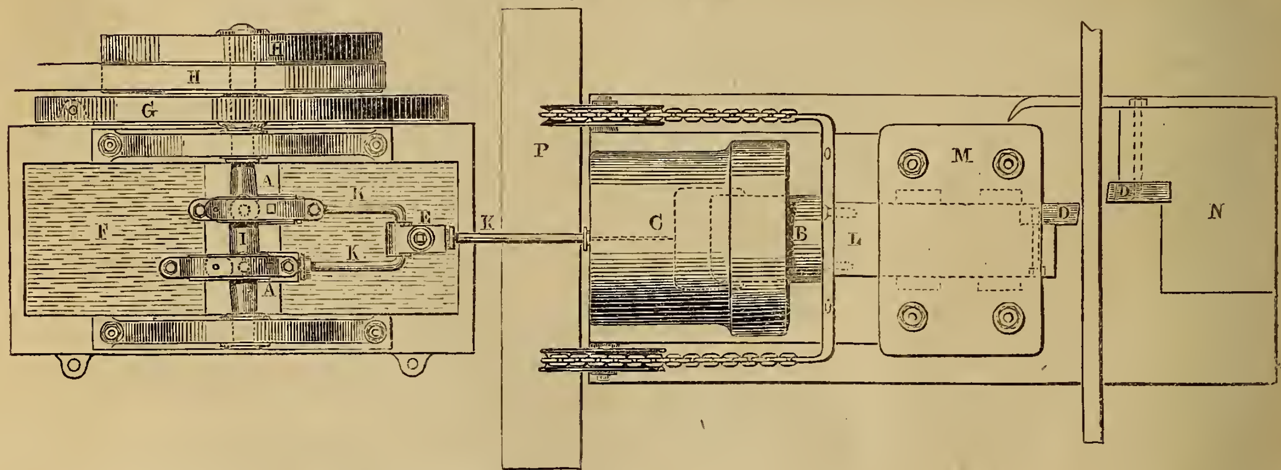


Fig. 2.—Plan.—Scale $\frac{1}{20}$.

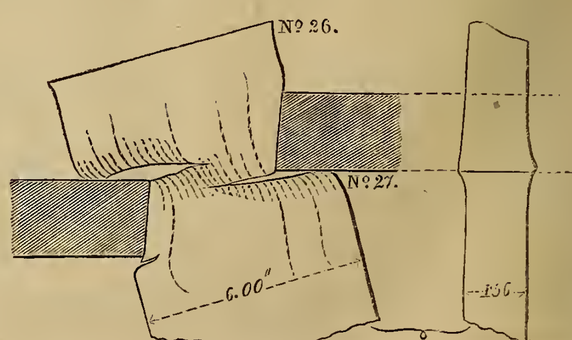


Fig. 3.—Scale $\frac{1}{6}$.

Fig. 4.—Scale $\frac{1}{6}$.

Some experiments have been made with this press at Mr. Eastwood's works, for the purpose of ascertaining the relative resistance of wrought iron to shearing in different thicknesses and proportions of width to thickness, this plan of press affording the opportunity of measuring the force actually employed at the moment of cutting by the pressure upon the hydraulic ram. The pressure was measured, as the most eligible method available, by hanging weights at the end of a long hand lever for working the force pump, the distance from the fulcrum to the pump being $3\frac{1}{4}$ in., and from weight to fulcrum 78 in., or 24 to 1; the area of the ram being $111\frac{3}{4}$ times that of the pumps, the total ratio of the actual pressure on the cutters to the load employed was 2,682 times. All the experiments were made with hammered scrap iron of uniform quality, and the following general results were obtained:—

Punching a 1 in. hole through $\frac{1}{2}$ in. and 1 in. bars required 36 and 69 tons respectively, or a mean of 22·5 tons per square inch of sectional area cut, as measured by the circumference of the hole multiplied by the thickness (experiments Nos. 1 and 2). Punching a hole 2 in. diameter through $\frac{1}{2}$ in., 1 in., and $1\frac{1}{2}$ in. bars successively, required 65, 132, and 186 tons respectively, giving a mean of 19·4 tons per square inch of the sectional area cut, or 14 per cent. less in punching the 2 in. holes than in the 1 in. holes (Nos. 3 to 6).

Shearing flat bars was tried with sections 3 in. by $\frac{1}{2}$ in., and 3 in. by 1 in., and the results gave a mean of 22·7 and 21·5 tons per square inch of sectional area cut, the difference being inconsiderable between the two directions of shearing, flatways or edgeways (Nos. 7 to 12).

In comparing the shearing of these sections, 3 in. by $\frac{1}{2}$ in. and 3 in. by 1 in., with the punching of a 1 in. hole through $\frac{1}{2}$ in. and 1 in. bars, the result is nearly the same in both cases with the $\frac{1}{2}$ in. thickness, and with the 1 in. thickness about 5 per cent. less in shearing than in punching, the area of section cut through being about the same in the cases of shearing as in those of punching.

TABLE.

Experiments on Punching.

No. of Experiment.	Diameter of punch.	Sectional area cut. Thickness and Circumference.	Area.	Load including lever.	Pressure on Punch. 2682 times load.	Total.	Tons per in. of area cut.	Remarks.
	Ins.	Ins. Ins.	Sq. in.	lbs.	lbs.	Tons.	Tons.	
1	1	0·51 × 3·14	1·60	29·9	80192	35·8	22·4	22·5 mean
2	1	0·98 × 3·14	3·08	57·9	155288	69·3	22·6	
3	2	0·52 × 6·28	3·27	49·9	133832	59·7	18·3	19·4 mean
4	2	0·57 × 6·28	3·58	58·9	157970	70·5	19·7	
5	2	1·06 × 6·28	6·66	110·9	297434	132·8	19·9	
6	2	1·52 × 6·28	9·55	155·9	418124	186·7	19·5	

Experiments on Shearing.

No. of Experiment.	Direction of shearing.	Sectional area cut. Thickness and Breadth.	Area.	Load, including lever.	Pressure on cutters. 2682 times load.	Total.	Tons per in. of area cut.	Remarks.	
		Ins. Ins.	Sq. in.	lbs.	lbs.	Tons.	Tons.		
7	Flat	0·50 × 3·00	1·50	27·9	74828	33·4	22·3	22·7 mean	Parallel Cutters
8	Edge	0·50 × 3·00	1·50	28·9	77510	34·6	23·1		
9	Flat	1·00 × 3·00	3·00	57·9	155288	69·2	23·1	21·5 mean	
10	Edge	1·00 × 3·00	3·00	56·9	152606	68·1	22·7		
11	Flat	1·00 × 3·02	3·02	49·9	133832	59·7	19·8		
12	Edge	1·00 × 3·02	3·02	51·9	139196	62·1	20·6		
13	Edge	1·80 × 5·00	10·20	175·9	471764	210·6	20·6	Flanged tyre	
14	Flat	0·56 × 3·00	1·68	17·7	47471	21·2	12·6		Inclined Cutters (angle 1 in 8)
15	Edge	0·56 × 3·00	1·68	27·7	74291	33·2	19·7		
16	Flat	0·90 × 3·37	3·03	22·9	61418	27·4	9·0		
17	Edge	0·87 × 3·32	2·89	47·9	128468	57·4	19·8		
18	Flat	1·06 × 3·02	3·20	41·9	112376	50·2	15·7		
19	Edge	1·06 × 3·02	3·20	56·4	151265	67·5	21·1		
20	Flat	1·52 × 3·03	4·61	69·9	187472	83·7	18·2		
21	Edge	1·53 × 3·03	4·64	77·9	208928	93·3	20·1		
22	Flat	1·39 × 4·50	6·25	74·9	200882	89·7	14·3		
23	Edge	1·38 × 4·50	6·21	92·9	249158	111·2	17·9		
24	Flat	1·73 × 5·30	9·17	127·9	343028	153·1	16·7		
25	Edge	1·73 × 5·30	9·17	172·9	463718	207·0	22·6		
26	Flat	1·56 × 6·00	9·36	116·9	313526	140·0	15·0		
27	Edge	1·56 × 6·00	9·36	143·9	385940	172·3	18·4		
28	Square	3·10 × 3·10	9·61	137·9	369848	165·1	17·2	Hammered iron	
29	Square	3·10 × 3·10	9·61	129·9	348392	155·5	16·2	Rolled iron	
30	Flat	1·80 × 5·00	10·20	82·9	222338	99·3	9·7	Flanged tyre	
31	Edge	1·80 × 5·00	10·20	154·9	415442	185·5	18·2	Flanged tyre	
32	Edge	1·70 × 5·25	10·57	149·9	402032	179·5	17·0	Flanged tyre	

In the above experiments of shearing, cutters with parallel edges were used; but when the ordinary cutters with edges inclined to one another at an angle of 1 in 8 were employed, the force required in shearing was diminished, and considerably so in the case of the thinner sections when sheared flatways; and as bars are usually sheared flatways, a decided advantage is shown in favour of inclined over parallel cutters. The force in tons per square inch of section cut with the bars:—

		Flatways. Tons.		Edgeways. Tons.		
$3 \times 1\frac{1}{2}$ in.	was	18·2	and	20·1,	or	10 per cent. less flatways.
$4\frac{1}{2} \times 1\frac{3}{8}$		14·3		17·9		20
3×1		15·7		21·1		26
$5\frac{1}{4} \times 1\frac{3}{4}$		16·7		22·6		26
$6 \times 1\frac{1}{2}$		15·0		18·4		18

A trial was also made of the force required to shear some hard railway tyres $1\frac{3}{4}$ in. thick, and the result was 185 tons total edgeways, and 99 tons flatways (Nos. 30 and 31).

A 3-in. square bar of rolled iron was also tried, and the force required was 155 tons total, against a total of 165 tons required for a hammered bar of the same section (Nos. 28 and 29).

Figs. 3 and 4 are drawings of the fracture of the bars in the Experiments Nos. 20 and 21, 26 and 27. The scale of Figs. 1 and 2 is 1-20th full size, and that of Figs. 3 and 4 is 1-5th full size.

In the course of the discussion which followed, Mr. E. JONES said, they had had one of the machines at work for several months at Wednesbury with very satisfactory results; it effected a great saving of time and labour in cutting up heavy scrap, cutting up old railway tyres at the rate of 15 or 16 tons per day. A great advantage in the machine was, that it could be instantaneously stopped at any point of the stroke; but in other machines the great momentum of the flywheel carried everything before it, causing extensive damage when an accident occurred. In the hydraulic machine the safety-valves could be weighted to any amount of force that the press was calculated to bear; and it required only a boy to attend to the pumps, and a man to shift the pieces for cutting.

Mr. J. FERNIE stated, he had seen the machine at work at Mr. Eastwood's, and thought it possessed considerable advantages. The novel arrangement of the shears, in a horizontal position and close to the ground, allowed great strength of the frame, and was a practical advantage in working for cutting up tyre bars; for there was a difficulty in the vertical machines in getting the tyre properly placed between the shears, but in this machine it could be readily bowled up and dropped into its place. The large shears used at the Midland Railway works for cutting up heavy scrap were three or four times as heavy and twice as expensive; but the hydraulic machine, weighing only 5 or 6 tons, without any foundations or fly-wheel or connecting-rods, cut up heavier sections of iron. The power of stopping the machine in working at any point of the cut, gave it a great superiority over all other shearing machines; for, although there was generally an arrangement in large machines by which the action of the tool could be stopped within 1-16th in. of the work, yet if it once entered it must go through, and there was no means of preventing a break down if anything went wrong. The hydraulic machine was not intended for cutting the ends square, but fully answered the purpose of cutting up scrap-iron, for which it was intended, and seemed as great an advancement in shearing as the circular saw was for cutting hot bars.

Punching by means of a hydraulic press had been tried before, he believed, and Mr. Hick, of Bolton, had entered largely into experiments on the subject, and had even punched the cotter holes in connecting rod ends. In the experiments described in the Paper it was worthy of consideration, that measuring by the sectional area of surface divided, the resistance to punching and shearing appeared to be about the same with moderate sizes; but with a large hole in thick iron the resistance to shearing was five per cent. less than to punching. He had witnessed several of the experiments, as had also the Secretary, and thought the results obtained might be relied upon.

It was stated that the cost of the machine shown in the drawings was about £200, including the pumps complete; that was the largest machine yet constructed, the ram being $9\frac{1}{4}$ in. diameter.

Mr. E. JONES informed the meeting, that he had made a set of experiments several years ago on the force required for punching different sized holes in different thicknesses of plates, up to 1 in. diameter and 1 in. thickness; the force was applied by means of dead weights, with a pair of levers, giving a total leverage of 60 to 1, so that 1 cwt. in the scale gave a pressure of 3 tons on the punch; the weights were added gradually by a few lbs. at a time until the hole was punched. The following results were obtained, which appeared to corroborate generally the experiments given in the Paper with larger sizes:—

Diameter of Hole.	Thickness of Plate.	Sectional area cut through.	Total Pressure on Punch.	Pressure per sq. in. of area cut.
In.	In.	Sq. in.	Tons.	tons.
0·250	0·437	0·344	8·384	24·4
0·500	0·625	0·982	26·678	27·2
0·750	0·625	1·472	34·768	23·6
0·875	0·875	2·405	55·500	23·1
1·000	1·000	3·142	77·170	24·6

It was remarked, that in the thinner plates the iron was more rolled, and might be expected to be denser and to offer more resistance to punching; moreover the thinner the plate, the greater was the ratio of the hard skins to the interior metal, causing, consequently, a greater resistance per square inch of sectional area. The appearance of the punched specimens seemed to agree with this view of the case.

ROYAL INSTITUTION OF GREAT BRITAIN.

June 11, 1858.

The Duke of Northumberland, K.G., F.R.S., President, in the Chair.

ON WHEATSTONE'S ELECTRIC TELEGRAPH IN RELATION TO SCIENCE (BEING AN ARGUMENT IN FAVOUR OF THE FULL RECOGNITION OF SCIENCE AS A BRANCH OF EDUCATION).

Professor Faraday, D.C.L., F.R.S.

The development of the applications of physical science in modern times has become so large and so essential to the well-being of man, that it may justly be used, as illustrating the true character of pure science, as a department of knowledge, and the claims it may have for consideration by Governments, Universities, and all bodies to whom is confided the fostering care and direction of learning. As a branch of learning, men are beginning to recognize the claim of science to its own particular place; for though flowing in channels utterly different in their course and end to those of literature, it conduces not less, as a means of instruction, to the discipline of the mind, whilst it ministers, more or less, to the wants, comforts, and proper pleasure, both mental and bodily, of every individual of every class in life. Until of late years, the education for, and recognition of, it by the bodies which may be considered as giving the general course of all education, have been chiefly directed to it only as it could serve professional services—namely, those which are remunerated by society. But now the fitness of university degrees in science is under consideration, and many are taking a high view of it, as distinguished from literature, and think that it may well be studied for its own sake, *i.e.*, as a proper exercise of the human intelligence, able to bring into action and development all the powers of the mind. As a branch of learning, it has (without reference to its applications) become as extensive and varied as literature; and it has this privilege, that it must ever go on increasing. Thus it becomes a duty to foster, direct, and honour it, as literature is so guided and recognised; and the duty is the more imperative, as we find by the unguided progress of science and the experience it supplies, that of those men who devote themselves to studious education, there are as many whose minds are constitutionally disposed to the studies supplied by it, as there are of others more fitted by inclination and power to pursue literature.

The value of the public recognition of science, as a leading branch of education, may be estimated in a very considerable degree by observation of the results of the education which it has obtained incidentally from those who, pursuing it, have educated themselves. Though men may be specially fitted by the nature of their minds for the attainment and advance of literature, science, or the fine arts, all these men, and all others, require first to be educated in that which is known in these respective mental paths; and when they go beyond this preliminary teaching, they require a self-education directed (at least in science) to the highest reasoning power of the mind. Any part of pure science may be selected to show how much this private self-teaching has done, and by that to aid the present movement in favour of the recognition generally of scientific education in an equal degree with that which is literary; but perhaps electricity, as being the portion which has been left most to its own development, and has produced as its results the most enduring marks on the face of the globe, may be referred to. In 1800, Volta discovered the voltaic pile, giving a source and form of electricity before unknown. It was not an accident, but resulted from his own mental self-education. It was, at first, a feeble instrument, giving feeble results: but by the united mental exertions of other men, who educated themselves through the force of thought and experiment, it has been raised up to such a degree of power as to give us light, and heat, and magnetic and chemical action, in states more exalted than those supplied by any other means.

In 1819, Oersted discovered the magnetism of the electric current, and its relation to the magnetic needle; and as an immediate consequence, other men, as Arago and Davy, instructing themselves by the partial laws and action of the bodies concerned, magnetized iron by the current. The results were so feeble at first as to be scarcely visible; but by the exertion of self-taught men since then, they have been exalted so highly as to give us magnets of a force unimaginable in former times.

In 1831, the induction of electrical currents one by another and the evolution of electricity from magnets was observed—at first in results so small and feeble, that it required one much instructed in the pursuit to perceive and lay hold of them; but these feeble results, taken into the minds of men already partially educated and ever proceeding onwards in their self-education, have been so developed as to supply sources of electricity independent of the voltaic battery or the electric machine, yet having the power of both combined in a manner and degree which they, neither separate nor together, could ever have given it, and applicable to all the practical electrical purposes of life.

To consider all the departments of electricity fully would be to lose the argument for its fitness in subserving education in the vastness of its extent; and it will be better to confine the attention to one application, as the electric telegraph, and even to one small part of that application, in the present case. Thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity as soon as the conduction of that power with extreme swiftness through metals was known, and grew as the knowledge of that branch of science increased. The thought, as realized at the present day, includes a wonderful amount of study and development. As the end in view presented itself more and more distinctly, points at first apparently of no consequence to the knowledge of the science generally, rose into an importance which obtained for them the most careful culture and examination, and the almost exclusive exercise of minds whose powers of judgment and reasoning had been raised first by general education, and who, in addition, had acquired the special kind of education which the science in its previous state could give. Numerous and important as the points are which have been already recognised, others are continually coming into sight as the great development proceeds, and with a rapidity such as to make us believe that much as there is known to us, the unknown far exceeds it; and that extensive as is the teaching of method, facts, and law, which can be established at present, an education looking for far greater results should be favoured and preserved.

The results already obtained are so large, as even in money value to be of very great importance; as regards their higher influence upon the human mind, especially when that is considered in respect of cultivation, I trust they are, and ever will be, far greater. No intention exists here of comparing one telegraph with another, or of assigning their respective dates, merits, or special uses. Those of Mr. Wheatstone are selected for the visible illustration of a brief argument in favour of a large public recognition of scientific education, because he is a man both of science and practice, and was one of the very earliest in the field, and because certain large steps in the course of his telegraphic life will tell upon the general argument. Without referring to what he had done previously, it may be observed that in 1840 he took out patents for electric telegraphs, which included, amongst other things, the use of the electricity from magnets at the communicator, the dial face, the step-by-step motion, and the electro-magnet at the indicator. At the present time, 1858, he has taken out patents for instruments containing all these points; but these instruments are so altered and varied in character above the former, that an untaught person could not recognise them. The changes may be considered as the result of education upon the one mind which has been concerned with them, and are to me strong illustrations of the effects which general scientific education may be expected to produce.*

In the first instruments powerful magnets were used, and keepers with heavy coils associated with them. When magnetic electricity was first discovered, the signs were feeble, and the mind of the student was led to increase the results by increasing the force and size of the instruments. When the object was to obtain a current sufficient to give signals through long circuits, large apparatus were employed, but these involved the inconveniences of inertia and momentum; the keeper was not set in motion at once, nor instantly stopped; and, if connected directly with the reading indexes, these circumstances caused an occasional uncertainty of action. Prepared by its previous education, the mind could perceive the disadvantages of these influences, and could proceed to their removal; and now a small magnet is used to send sufficient currents through 12, 20, 50, a hundred, or several hundred miles; a keeper and helix is associated with it, which the hand can easily put in motion; and the currents are not sent out of the indicating instrument to tell their story until a key is depressed, and thus irregularity contingent upon first action is removed. A small magnet, ever ready for action and never wasting, can replace the voltaic battery; if powerful agencies be required, the electro-magnet can be employed without any change in principle or telegraphic practice; and as magneto-electro currents have special advantages over voltaic currents, these are in every case retained. These advantages I consider as the results of scientific education, much of it not tutorial, but of self; but there is a special privilege about the science-branch of education—namely, that what is personal in the first instance immediately becomes an addition to the stock of scientific learning, and passes into the hands of the tutor, to be used by him in the education of others, and enable them in turn to educate themselves. How well may the young man entering upon his studies in electricity be taught by what is passed to watch for the smallest signs of action, new or old; to nurse them up by any means until they have gained strength; then to study their laws, to eliminate the essential conditions from the non-essential, and at last to refine again, until the encumbering matter is as much as possible dismissed, and the power left in its highly developed and most exalted state.

The alterations or successions of currents produced by the movement of the keeper at the communicator, pass along the wire to the indicator at a distance; there each one for itself confers a magnetic condition on a piece of soft iron, and renders it attractive or repulsive of small permanent magnets; and these acting in turn on a propelment, cause the index to pass at will from one letter to another on the dial face. The first electro-magnets, *i.e.*, those made by the circulation of an electric current round a piece of soft iron, were weak; they were quickly strengthened, and it was only when they were strong that their laws and actions could be successfully investigated. But now they were required small, yet potential. Then came the teaching of Ohm's law; and it was only by patient study under such teaching that Wheatstone was able so to refine the little electro-magnets at the indicator as that they should be small enough to consist with the fine work there employed, able to do their appointed work when excited in contrary directions by the brief currents flowing from the original common magnet, and unobjectionable in respect of any resistance they might offer to the transit of these tell-tale currents.

These small transitory electro-magnets attract and repel certain permanent magnetic needles, and the to-and-fro motion of the latter is communicated by a propelment of the index, being there converted into a step-by-step motion. Here everything is of the finest workmanship; the propelment itself requires to be watched by a lens, if its action is to be observed; the parts never leave hold of each other; the vibratory or rotatory ratchet wheel and the fixed pallets are always touching, and thus allow of no detachment or loose shake; the holes of the axes are jewelled; the moving parts are most carefully balanced, a consequence of which is, that agitation of the whole does not disturb the parts, and the telegraph works just as well when it is twisted about in the hands, or placed on board a ship or in a railway carriage, as when fixed immovably. When it is possible, as in the vibratory needle, the moving parts are brought near to the centre of motion, that the inertia of the portion to be moved, or the momentum of that to be stopped, should be as small as possible, and thus great quickness of indication obtained. All this delicacy of arrangement and workmanship is introduced advisedly; for the inventor, whom I may call the student

* The former and the present apparatus were set to work in illustration of the points as they were noticed.

here, considers that refined and perfect workmanship is more exact in its action, more unchangeable by time and use, and more enduring in its existence, than that which being heavier, must be coarser in its workmanship, less regular in its action, and less fitted for the application of force by fine electric currents.

Now there was no accident in the course of these developments; if there were experiments, they were directed by the previously-acquired knowledge; every part of the investigations was made and guided by the instructed mind. The results being such (and like illustrations might be drawn from other men's telegraphs or from other departments of electrical science), then if the term education may be understood in so large a sense as to include all that belongs to the improvement of the mind, either by the acquisition of the knowledge of others or by increase of it through its own exertions, we learn by them what is the kind of education science offers to man. It teaches us to be *neglectful* of nothing—not to despise the small beginnings, for they precede of necessity all great things in the knowledge of science, either pure or applied. It teaches a continual comparison of the *small and great*, and that under differences almost approaching the infinite, for the small as often contains the great in principle as the great does the small, and thus the mind becomes comprehensive. It teaches to deduce principles carefully, to hold them firmly, or to suspend the judgment. To discover and obey *law*, and by it to be bold in applying to the greatest what we know of the smallest. It teaches us first by tutors and books to learn that which is already known to others, and then by the light and methods which belong to science to learn for ourselves and for others, so making a fruitful return to man in the future for that which we have obtained from the men of the past. Bacon, in his instruction, tells us that the scientific student ought not to be as the ant, who gathers merely, nor as the spider, who spins from her own bowels, but rather as the bee, who both gathers and produces.

All this is true of the teaching afforded by any part of physical science. Electricity is often called wonderful—beautiful; but it is so only in common with the other forces of nature. The beauty of electricity, or of any other force, is not that the power is mysterious and unexpected, touching every sense at unawares in turn, but that it is under *law*, and that the taught intellect can even now govern it largely. The human mind is placed above, not beneath it; and it is in such a point of view that the mental education afforded by science is rendered super-eminent in dignity, in practical application, and utility; for, by enabling the mind to apply the natural power through law, it conveys the gifts of God to man.

THE SOCIETY OF FOREMEN ENGINEERS.

It may be that many of our readers are not aware of the existence even of an Association closely allied in its interests with, and therefore entitled to the sympathy of, Engineers, and which noiselessly, but most usefully pursues the even tenor of its way in the City of London: we mean the Association of Foremen Engineers. It was in 1851, we believe, that the idea was first entertained of its formation. The heads of the civil and mechanical engineering communities, it was observed, had united themselves for mutual advantage, and had their periodical meetings for discussion, &c., and hence arose the thought that the managing agents of these heads (the foremen engineers) might in a more humble way follow their example. A few brave spirits met together soon after, and with that energy which is a characteristic of the particular class of men, determined that such conception should be realized. It is not necessary here to recount the difficulties which one by one arose, and which were successfully overcome, before the society became an established fact. By "gradual steps and slow" it worked its way forward, and its members increased. Rules were drawn up for its government, the nucleus of a library was formed, papers on practical subjects illustrative of engineering were periodically read, and by 1853 the machinery of the association was fairly in motion. The unassuming manner in which this success had been achieved, and the valuable nature of the institution altogether, now became known among the leading men of many London firms, and these hastened to add their names to its list of members. At this moment it boasts of having forty ordinary and honorary members, the meetings being held monthly in the Assembly-room of the Bay Tree Tavern, St. Swithin's Lane, City. Mr. Sheaves, of Messrs. Grissells' establishment, Eagle Wharf Road, is the president. It may be said that there are benefits derivable from this association in a pecuniary as well as in an intellectual sense, and that it is not exclusively metropolitan. It is not necessary to allude to the merits of the class of persons who comprise the body of associated foremen engineers; the fact of their having attained to such a position is a guarantee of their talent and probity. Knowing this, we have peculiar pleasure in diffusing yet more widely a knowledge of the nature of their society, and in claiming for it further public support.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

HUMBOLDT (A.)—Cosmos: Sketch of a Physical Description of the Universe. By Alexander Von Humboldt. Vol. 4, Part I. Translated under the superintendence of Major-General Edward Sabine. Post 8vo, pp. 640, cloth, 15s. (Longman.)

WHEWELL (W.)—History of Scientific Ideas: being the First part of the Philosophy of the Inductive Sciences. By William Whewell. 3rd edit. 2 vols, post 8vo, pp. 650, cloth, 14s. (J. W. Parker.)

A COLLECTION of PROBLEMS in illustration of the Principles of Theoretical Hydrostatics and Hydronamics. By W. Walton, M.A. 8vo, 10s. 6d. (Bell and Daldy.)

WALTON (W.)—A Collection of Problems in illustration of the Principles of Theoretical Mechanics. By W. Walton, M.A. 2nd edit. with numerous Alterations and Additions, 8vo, 18s. (Bell and Daldy.)

WEBSTER (J.)—The Principles of Hydrostatics; an Elementary Treatise on the Laws of Fluids and their Practical Application. By J. Webster, M.A. 4th edit. crown 8vo, 7s. 6d. (Bell and Daldy.)

SLIGHT (J.) and BURN (R. S.)—The Book of Farm Implements and Machines. By James Slight and R. Scott Burn. Edited by Henry Stephens. Royal 8vo, pp. 660, half-bound, 42s. (Blackwood.)

COLLINS' RAILWAY and Pedestrian Atlas of England; containing 43 Maps, with all Railways and Roads accurately laid down. Post 8vo, cloth, 2s. 6d. (Darton.)

DEANE'S Manual of the History and Science of Fire-arms. 8vo, woodcuts, 7s. 6d. (Longman, Brown and Co.)

WHEWELL (W.)—Conic Sections; their principal Properties proved Geometrically. By the Rev. W. Whewell, D.D. Third edit. 8vo, 2s. 6d. (Bell and Daldy.)

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*—ED.]

HOSPITAL OF THE MATER MISERICORDLÆ, DUBLIN.

To the Editor of The Artizan.

SIR,—With reference to your Dublin correspondent's notice of the above work permit me to say, the want of sufficient hospital accommodation for the poorer classes induced the religious community of the "Sisters of Mercy" to purchase a plot of unoccupied ground, nearly four acres in extent, at the upper end of Eccles Street, on which the erection of a public hospital has been commenced. The building, when completed, will be quadrangular in plan, and will extend in each direction about 330 ft., enclosing a great court. The ground floor will contain the entrance and waiting rooms for out-patients of both sexes, physicans' and surgeons' rooms, and private consulting rooms, out-patients' dispensary, ward dispensary, and laboratory. In each wing will be the temporary accommodation wards and bath rooms, and in the flanks will be the wardrobes for both sexes, together with fumigating rooms, ward stores, ophthalmic wards, servants' refectories, &c. The rear of ground storey will contain the great kitchen, hospital stores, laundry and drying room, boiler room, steaming and pumping apparatus, &c., &c. The principal floor will be approached by two flights of circular stairs, leading through a portico of granite columns 3 ft. 6 in. diameter to the entrance hall, which communicates with the great staircase, 34 ft. square, lighted from above. Behind and adjoining the great staircase a large building will project into the great court, and will contain offices and sitting rooms, operation wards, operation hall, capable of accommodating 300 students, apparatus room, and operating room, &c., and behind will be the pathological museum. On each side of the entrance hall are the reception rooms, physicians' and surgeons' rooms, linen dispensary, accident wards, and convalescent rooms. Each flank of the building on the upper floors will be occupied with the wards for male and female patients and convalescent rooms. Projections in the centres of each flank will contain staircases, ward kitchens, baths, &c., &c. Projections in the angles of the great court will also contain staircases, closets, lifts, &c., and will be covered with iron tanks for the supply of water. The rear of building in the upper floors will contain twenty-eight private rooms for paying patients; also the chapel, which will be cruciform in plan, and divided into nave and aisles by pilasters, &c., and surmounted by a dome ceiling. Behind the chapel, and in communication with it, will be erected the convent for the nuns. Corridors on each storey surround the great court, and are intended to serve as promenades for convalescents. The front portion of building will be surmounted by a cupola and dome 120 ft. in height, and the chapel will also have a campanile 100 ft. in height, both being intended to assist in the system of ventilation which has been adopted. The hospital will accommodate, in case of necessity, between 600 and 700 patients; but it is intended to retain in the house, after recovery, for some time, such of the poor patients as may be unable to procure the necessary sustenance and care, to prevent a relapse. As the building will be chiefly erected by public subscription, its progress is necessarily slow, the front portion only being now in course of erection. The style of the building is Italian, of a grave and massive character. The interior arrangement has been considerably modified (since the design was matured), at the instance of the projectors, and this, of course, has caused considerable change in the exterior appearance from the original design. Mr. John Bourke is the architect, his designs having been selected from among others submitted. Mr. John Brady is the builder of the portion in progress. These are the correct particulars relating to the above work. DUBLIN.

To the Editor of The Artizan.

SIR,—In your June number, page 145, I stated "There is a very large vessel to be towed, and one of the ordinary tugs with two engines, each 20 H.P., will move her at $1\frac{1}{2}$ miles per hour. Now we want to move her *twice as fast*. Would Mr. Atherton have FOUR TUGS or EIGHT TUGS to do it?" Mr. Atherton snubs me in your last number for employing the word "miles" when I meant nautical miles—as it caused him to misapprehend my meaning. Why does not he give a categorical answer to the above question? Surely its meaning is obvious enough. Yet he evades it. Who is to blame for this evasion?

With regard to engine power, Mr. Atherton and myself think precisely alike. If the indicator be perfect, and it shows that the steam overcomes a pressure of a certain amount, with a given number of strokes per minute, then, when the indicator shows four times that amount of pressure to be overcome with a two-fold velocity of piston, I have no doubt that the power developed by the engine is *eightfold* in a given time.

But I have three serious objections to Mr. Atherton's solution of the problem I proposed. First: it is *irrelevant*. We are endeavouring at present to ascertain the *work done* upon the water by the transit of the ship. The question was *how many* tugs. Instead of ascertaining and telling us the number, he proposes to confine himself to one and to quadruple the steam pressure and double the number of strokes.

Second: It is *impossible*. We do not wish to burst our boilers, and we cannot, as Mr. Atherton knows, make the machinery of any steam tug subservient to a fourfold pressure of steam and a double number of strokes.

Thirdly: It is *based upon misconception*. If the required pressure could be

obtained in the boiler, the question is whether the indicator could show a fourfold "pressure" in the cylinder while the wheels revolved only twice as fast. This admits of discussion. But just now it would be premature to enter upon such inquiry. Let us first determine the amount of power expended by the ship upon the water, and then inquire what steam power *must* be expended upon the water by the propelling instrument, so that its reaction shall amount to the power expended by the ship.

Suppose I grant Mr. Atherton a fourfold pressure of steam in the one tug. I ask him, as an engineer, whether he would not extend the periphery of his centres of paddle-pressure, and perhaps increase the area of paddle surface; in short, whether he would not economise steam by a re-adaptation of the paddle-wheel? I know he would. But then, if with the wheel in its primitive state, only an eightfold expenditure of steam would take place to produce a double velocity of vessel, it is clear that a less expenditure of steam would take place with the improved wheel. Thus the "cube theory" again breaks down. I feel persuaded that Mr. Atherton will soon agree with me, that steam power, at its *minimum*, *must* vary as the *square* of the velocity; that it *may* vary as the *cube* of velocity; but that between square and cube is the space in which the skill of the engineer may be manifested.

Mr. Atherton's assumption that a tug towing varies the number of revolutions of her paddle-wheels in the precise ratio of the variation of the speed at which she tows will not bear a moment's examination; and his idea that when she tows the same vessel at a double velocity there is a fourfold stress upon the tow-rope, evinces that a brief reference to "rudimentary" considerations would do him no harm.

The learned, instructive, and most amusing author of the "History of the Inductive Sciences," states that "the accordance which engineers are able to obtain between their calculations and observed results, is very great; but these calculations are performed by means of empirical formulæ, which do not connect the facts with their causes." Mr. Atherton's formula is not entitled even to this doubtful recommendation; and should he formulate his notions respecting the stress upon a "Tug's" tow-rope, and the number of revolutions made by her paddle-wheels while she is towing vessels of various sizes, it is obvious to the merest tyro in mechanics that he will not "obtain even anything like the accordance" Dr. Whewell refers to. G. J. Y.

THE CONSERVATION OF THE MECHANICAL EFFECT OF FORCE.

To the Editor of The Artizan.

Sir,—I question whether Mr. J. Scott Russell, or any other gentleman who took a prominent part in the discussion on my Paper on "High Speed Steam Navigation," at the Institution of Civil Engineers, could produce a process less empirical for the requirement (21 miles per hour) of the Directors of the Holyhead and Kingstown Mail Steamers, than that produced in the July Number of The Artizan by the engine builders of the *Caradoc*.

The suggestion thrown out by Mr. J. E. M'Connell, for each engineer or shipbuilder to produce their formula and its results, when applied to well-authenticated performances of steam-vessels, so as to be placed in opposition to my own, would certainly have been the best means of exhibiting the present state of naval architecture and the science of marine engineering; therefore, by their non-production "it really seemed as if those who laid claim to a practical knowledge of the subject were incompetent to give any good rule for determining the relative proportion of any one of the conditions of a steam-vessel."

Now, as the object of my communications in The Artizan has been to construct the science of naval architecture and hydro-dynamics, the production of the requirements for 21 miles per hour will form a suitable subject for discussion in your columns.

Permit me, before producing those requirements, to recapitulate the basis of my "*peculiar views*," and the principles I have advocated in your columns, against which I defy anyone to controvert, either by fact or tenable argument—

First. "That the mechanical effect (foot lbs.) of force can neither be created nor annihilated;" or, in other words, can neither be increased nor diminished by any mechanical appliance.

Second. That the mechanical effect is always in the proportion to the force and *time* employed, and not to the force and its *velocity*.

Third. That the amount of the mechanical effect of a force of 1 lb. is 1 lb. retarding pressure through 1 ft. in 1 second of time.

Fourth. That *time* in dynamics corresponds with space in statics—that is, a given force to produce a twofold mechanical effect requires a double amount of time; or, in statics, a force to produce an equilibrium with a twofold weight requires a double space on the lever from the fulcrum.

Fifth. That there is a space (to be determined) in which force acts to produce that amount of mechanical effect mentioned in the third definition, and which, I venture to assert, will be found under 2 ft. per second.

Sixth. That there is no friction between a solid and a fluid, or that displacement in the line of direction does not materially add to the resistance; and

Seventh. That when a force for any mechanical operation increases as the square of the velocity, *the retarding pressures can only increase as the simple speeds.*

These definitions are my reading of the fundamental principles of mechanics, which I assert, when applied to steam navigation, will point out the exact requirement for any rate of velocity; separate the performance of the machinery from the question of the form of vessel; and the power of ascertaining whether the engine or vessel is performing the duty for which it was designed—the object of my Paper on "High Speed Steam Navigation."

The suggested problem may be thus briefly stated: A vessel is required the average velocity of which shall be 21 miles per hour (30 ft. per second), the size not larger than consistent with perfect safety at all times of the year between Kingstown and Holyhead, and let it be perfectly understood that speed is the sole object; therefore that velocity at the lowest practical cost is the desideratum.

In proceeding with the solution of the above proposition, we have *only* one important fact established by both theory and experiment, viz.: that the force

	Actual Speed.—Feet per Second.	Midship Section.	Pressure in Cylinders (Force).	Velocity of Piston Feet per Second.	Deduced Velocity.—Feet per second.	Ratio of Speeds.	I. H. P.	Actual Speed. Miles.	V^2 miles $= \frac{\frac{2}{3} \text{ I. H. P.} \times 100}{\text{Mid. Secs.}}$	Ratio of Speeds.	
Anglia	21·75	188	119680	3·75	25·21	·86	816	14·90	16·97	·87	C. and H. M. Steam.
Cambria	21·57	230	137859	3·83	24·47	·88	960	14·75	16·67	·88	,,
Scotia	22·83	182	141625	3·60	27·87	·82	927	15·64	18·41	·85	,,
Atrato	23·60	544	338843	5·47	24·93	·94	3070	16·08	19·40	·83	W. I. Mail.
Valetta	22·97	270	162455	4·31	24·51	·93	1272	15·53	16·85	·92	P. and O. Company.
Singapore	19·16	334	158230	3·90	21·74	·88	767	13·23	14·93	·86	,,
Indus	17·00	525	214814	3·50	20·22	·84	1367	11·43	13·15	·87	,,
Ripon	17·00	491	214814	3·33	20·90	·81	1200	11·43	12·76	·89	,,
Screw Vessels.											
Himalaya	23·49	556	175714	6·41	17·74	1·32	2050	15·88	15·66	1·01	P. and O. Company.
Cadiz	19·59	262	92366	3·86	15·58	1·25	450	13·25	10·67	1·24	,,
Candia	21·38	527	162135	4·80	17·52	1·22	1415	14·45	13·37	1·08	,,
Pera	21·34	548	173880	4·33	17·86	1·19	1373	14·43	12.92	1·11	,,
Alma	20·50	541	164431	4·83	17·40	1·17	1445	13·86	13·34	1·03	,,
Colombo	21·01	505	165810	4·85	18·11	1·16	1463	14·21	13·89	1·02	,,
Norna	20·19	253	94796	4·00	19·31	1·04	690	13·65	13·45	1·01	,,
Minx, diminished	9·19	59	4097	4·90	8·30	1·10	36½	6·21	6·22	·98	H. M. Service.

necessary to propel a plane increases as the square of the velocity, and nearly in the following proportions: Force $= A\,V^2$ ft. per second. It is slightly in excess of what the formula of Colonel Beaufoy, Dubuat, and experiment gives, but is adopted as more convenient in practice, and sufficiently near for all practical purposes. Consequently, by conceding the previous definitions of the principles of mechanics, the formula Force $= A\,V^2$ contains all the elements that are necessary to be taken into consideration when any requirement in steam navigation is demanded, which I will now test by eight paddle-wheel and eight screw steamers. It is only necessary to observe that the deduced velocity in the fifth column is obtained by the formula $V^2 = \frac{\text{Force}}{\text{Mid. Sec.}}$, and in the ninth column by $V^2 \text{ miles} = \frac{\frac{2}{3} \text{ Ind. H.P.} \times 100}{\text{Mid. Sec.}}$, which is introduced to exhibit the uniformity of my two modes of calculating the speed of paddle-wheel steamers, and in the screw vessels to exhibit that when indicated H.P. is employed (the velocity of the piston being introduced), the variation in the ratio of speeds can only be attributed to the various velocities of the piston, which clearly exhibits *that the effective power of the indicated H.P. diminishes with the increased velocity of the piston*; the same fact being exhibited by the *Miranda*, *Pioneer*, *Flying Fish*, and *Victor*, in my previous communication.

By a perusal of the data in the above tabulation we find that if the *average pressure in the cylinders* be taken as the force exerted by the engine, the speed of the vessel may be depended upon with the greatest certainty, when the terms of the formula $F = A\,V^2$ are fulfilled with the screw-propeller; but with the paddle-wheel it will require Force $\times$ ·70 $= A\,V^2$ to obtain the speed required; consequently the paddle-wheel requires 80 per cent. more power than the screw, therefore is more expensive in that proportion; as examples take the *Himalaya* and *Atrato*, the force in the latter being twice that in the former.

The same facts are exhibited in a comparison of the *Valetta* with the *Candia*, *Pera*, and *Colombo*. In the four vessels there is nearly an equal force employed, while the midship section in the former is only one-half that of the three latter. With such facts as these before me, I have not the slightest hesitation in asserting that the days of paddle-wheels are numbered.

With reference to the magnitude of the vessel for the station between Kingstown and Holyhead, either of the three vessels *Anglia, Cambria*, or *Scotia*, lengthened in midships 50 ft., retaining the same formed ends, would have been amply sufficient; the dimensions, then, would be as follows:—

	Scotia.		*New Scotia.*	
Length	195	ft.	245	ft.
Breadth	27·5	ft.	27·5	ft.
Draft	8·75	ft.	8·75	ft.
Mid-Section	182	ft.	182	ft.
Displacement	600	tons	860	tons
Speed	22·83	ft. per second	30	ft.
Force for paddle	141,625	lbs.	234,000	lbs.
Force for screw	94,822	lbs.	163,800	lbs.

With these dimensions, power, &c., of the new *Scotia*, I will exhibit the power of discrimination obtained by the steam-ship owner, in adopting these principles as the basis for the separation of the question of form from the performances of the machinery.

To the Shipbuilder.—You have to supply a vessel of the above dimensions, of sufficient strength, stability in a seaway, steering properties, and, if a screw vessel, the after water-lines must be made suitable for that instrument of propulsion; and let it be perfectly understood that the indispensable condition of the contract is to supply 860 tons displacement at an immersed midship section of 182 sq. ft.

To the Engineer.—It is required that the boilers and engines shall be able to maintain, if for a paddle-wheel steamer, 234,000 lbs., or for a screw 163,800 lbs. average pressure (vacuum included, steam cut off at half stroke, and the usual deductions allowed), at a velocity of 3 ft. per second. You are at liberty to use your own discretion in selecting the form of paddle-wheel or screw propeller; but the indispensable condition of the contract is, that the speed of the vessel shall be 21 miles per hour.

In the above amounts of force I have allowed for the variation in the efficiency of the screw and paddle-wheel (obtained empirically); any addition for friction on the lengthened vessel is not required; as examples, a comparison of the *Minx* with the *Himalaya* and *Conqueror* is sufficient proof that it is not necessary in any calculation of velocity; and whatever advantage may be in the bow of the *Scotia* for speed, that element is not calculated; therefore, if the vessel does not complete 21 miles per hour, the engines or propeller does not possess the power of transmitting the force in the cylinders to the vessel, for upon no consideration can the bow of the vessel be admitted worse than a plane.

It is a very common observation with some of your correspondents "that figures may be made to prove anything." Allow me to suggest their application to controvert any of my "peculiar views," or produce a better basis for the separation of the question of form from the performances of the machinery—the desideratum of the sciences connected with steam navigation.

In corroboration of the assertion in my previous communication, "that the wear and tear of the engines and consumption of fuel is 50 per cent. in excess of the actual requirement," a quotation (704) from the "Manual of Applied Mechanics," by W. J. Macquorn Rankine, President of the Institution of Engineers, Scotland, published 1858, is sufficient to prove that the power of the steam-engine demands investigation: "The duty of an engine is the work performed by a given quantity of fuel, such as 1 lb. The duty of a pound of coal varies in different classes of engines from about 100,000 to 1,200,000 foot lbs. *These are extreme results as respects wastefulness on the one hand, and economy on the other.* In good ordinary engines the duty varies from 200,000 to 500,000."

Again, I may safely add, that these results are very far from creditable to the science of civil engineering.

I am, Sir, your obedient servant,
R. Armstrong.

APPLIED MECHANICS.

To the Editor of The Artizan.

Sir,—Your reply to Mr. T. Walliss, in the "Notices to Correspondents," may safely be attributed to the *faulty mode* of expressing my opinions. If you will again refer to my communication in the May Number of The Artizan, you will find that I make the maximum of mechanical effect of a force of 1 lb. equal to 1 ft. lb.—not 4 ft. lbs.—raised the *same space* in the same unit of time. To have advanced such a principle would have been "too absurd to entitle it to a moment's consideration." If Mr. Walliss will honour me with another perusal of the communication, he will find that the 4 lbs. is only raised 3 in. in one second, consequently only 1 ft. lb. Perhaps if the column of ft. lbs. had been added to my numerical illustration, the misconception would not have occurred.

Allow me to state that the object of that Paper was to supply a rule for an everyday want, and which is not to be found in any modern work on "Applied Mechanics," viz.—What is the requirement to raise 1,000 lbs. 50 ft. high per second?—the answer being, that the weight multiplied by the velocity required in feet per second is the indispensable amount of force required to perform that amount of work in that time. If two seconds be the time, then half that amount of force (25,000 lbs.) will be the required amount. I assert it to be an impossibility for 25,000 lbs., by any mechanical appliance, to perform the requirement (50,000 ft. lbs.) in one second. It only remains to add that these amounts are theoretical but if the average pressure in the cylinders (steam cut off at half stroke) be adopted as the force exerted, that amount will be sufficient.—I am, Sir, your most obedient servant,

R. Armstrong.

P.S. If Mr. Wallis will consult Atwood, page 238, he will find the demonstration of the principle denominated *Conservatio virium vivarum*, as far as it is consistent with truth, viz., mechanical effect, and much valuable information on the fundamental principles of mechanics.

STEAM-SHIP RESISTANCE.

To the Editor of The Artizan.

Sir,—I beg to decline endorsing the inference drawn upon me by Mr. Moy's letter in your last Number (No. clxxxvi.), and I am desirous to leave no opening for inferences or doubt as to what I regard as the best mode of determining the relative dynamic merits of various types of steam-ship build. I regard that type of form as the most effective for the performance of dynamic duty by steam power (without reference to other nautical properties) which, *cæteris paribus*, when put on trial, and practically tested by the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}}$, gives the highest numerical quotient. I hold that it is by thus utilising our experience of the actual trial performances of steam-ships of various types of form, and by statistical record of the data thus obtained, and of the coefficients deduced therefrom by the formula referred to, that the problem of the properties to be expected of an intended ship of any given and known type will be best solved; for the coefficient that ought to and will, if all is right, be realised by the intended ship having been thus approximately predetermined, the equation expressing the mutual relation of displacement, power, and speed, becomes complete, and any two of those quantities being given, the third may be found. As to the "wave line," I doubt if there be any ship afloat of which the lower run lines of the after body are not curves of contrary flexure, partaking approximately of the general character of the wave line; and such curves also commonly occur in the lower lines of the fore body, as a consequence of the ordinary methods of laying off ships even of which the deep draught lines are convex. The purport of my remarks has not been to reprobate the use of such curves of contrary flexure, but to expose the fallacy of classing a particular development of such curves as being of exclusively modern application to shipping, and of attributing to them, when made, the characteristic feature of the deep draught lines of ships—extravagant properties for excellence, as respects dynamic effect—but which such curves are not found to possess when examined theoretically as by Dr. Eckhardt, or experimentally as by Mr. Gore (see "Steel's Naval Architecture," second edition), or when the sea trial performances of such vessels are practically tested in comparison with other types by the formula to which I have referred.

I may exemplify this statement by reference to the last Number of The Artizan (No. clxxxvi., page 163), wherein are recorded the well-authenticated particulars of the trial of a new paddle-wheel steamer *Admiral*, length 211·3 ft., breadth 32·1 ft., trial draft 7·42 ft., working power 744 indicated H.P., speed 11·87 knots, the vessel being described as "*modelled in accordance with what is known as the wave theory;*" and as in such type of form the displacement seldom exceeds 6-10ths of the product of L × B × D, we may assume the trial displacement, which is not given in the record, at probably 840 tons, and accordingly we find the coefficient or index number of dynamic duty of this avowedly "wave-line" vessel to be 200, being below the coefficients of the somewhat similar paddle-wheel vessels *Banshee* and *Llewellyn*, which were built without any pretension to the wave-line type.

In the discussions which have taken place on the asserted dynamic capabilities of the *Leviathan*, the part taken by me has usually been in refutation of statements which I regarded as chimerical, and not deducible by any recognized law from the ascertained capabilities of any existing steam-ships. Such is not a pleasant part to take in respect of a popular enterprise, the object of universal interest, and of general hope that it may successfully open up a new era of intercommunication between the most distant regions of the globe. I have, therefore, much pleasure in bringing before the notice of your readers the following statement, based on the formula referred to as to the dynamic capabilities of large ships in a point of view which I regard as the prominent feature on which the advantage of the surpassing magnitude of the *Leviathan* is mechanically borne out: that is to say, the larger we construct a ship, the smaller will be the ratio of power to displacement at which any *given speed* will be attained. For example: a ship of 20,000 tons mean displacement, such as the *Leviathan*, assuming her coefficient of dynamic duty to be 215·5, may be expected to be impelled at the speed of 10 knots per hour by 1 indicated H.P. to each 6 tons of displacement; but a ship of 12,500 tons displacement, of the same type of build, may be expected to require 1 indicated H.P. to each 5 tons of displacement; a similar ship of 5,000 tons displacement may be expected to require 1 indicated H.P. to each 4 tons of displacement; a similar ship of 2,250 tons displacement may be expected to require 1 indicated H.P. to each 3 tons of displacement; and a similar ship of 1,000 tons displacement may be expected to require 1 indicated H.P. for each 2 tons of displacement, to attain the speed of 10 knots per hour.

Having now pretty well exhausted this subject (the dynamic capabilities of steam-ships), at least so far as my own ideas are concerned, I hope there may be no occasion for my further intrusion on the liberality with which you have admitted this discussion to the pages of The Artizan, excepting that it would give me much satisfaction hereafter to be enabled to acknowledge that the *Leviathan* has realised the predictions of her most enthusiastic advocates.

I am, Sir, your very obedient servant,
Woolwich Dockyard, 15th July, 1858. Chas. Atherton.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we purpose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar and intelligible shape.—Ed.

Colliery Explosion.—Alleged Negligence of a "Fire-Trier."—At the late York Assizes (Northern Circuit, Crown Court, before Mr. Baron Martin), Matthew Littlewood was indicted for the manslaughter of Matthew Jagger, at Wombwell, on the 4th of May last. The accused was one of four "fire-triers" at the Wombwell Main Colliery, and his duty was on the 4th of May last to try certain "broadgates" in the colliery with a Davy lamp, by holding it up along the face of the "broadgate" as he passed along, to try whether there was any lodgement of gas in the passage. Gas, from its nature, rose to the roof, and only descended as the quantity increased. It was prisoner's duty to try the broadgate at six o'clock in the morning, before any of the workmen entered the pit, and on pronouncing it free from gas the workmen and others could go down. One of these "broadgates," or passages through the coal, was an old working, and had not been used for some months. The accused, according to his statement, went down this passage that morning at six o'clock, swinging the Davy lamp suspended to his thumb, and neither smelt nor saw any indications of gas accumulation. On the part of the prosecution, it was contended that he ought to have held it up to the roof. At ten o'clock that morning a surveyor visited the pit for the purpose of making a survey of the quantity of the coals taken, on behalf of Sir George Wombwell; he was accompanied by the deceased, Matthew Jagger, who was his pupil, and six miners; and whilst making his survey, one of the miners held up a naked candle to the face of the "broadgate," and an immediate explosion followed, which so burnt the deceased that he subsequently died of erysipelas consequent on the injuries he had received. For the defence it was elicited, that there was another explosion an hour and a half after in the same place from an accumulation of gas, and that it was dangerous and improper for any one to visit the pit, as had been done, with naked lights. Anything amiss in the trap-doors in the air-passages to interfere with the air currents would soon cause such an accumulation of gas. The accused bore an excellent character as a first-rate workman and careful "fire-trier." The Judge, in summing up, directed the Jury that they must be satisfied that the prisoner had been guilty of gross and culpable negligence in the performance of his duty to render him amenable to the law for the death of the deceased. It must not be mere ordinary carelessness. If they thought the accumulation of gas was attributable to, or not discovered by, such negligence, they must find him guilty; if not, they must acquit him. The jury found the prisoner "Not guilty."

Liability of Railway Pointsmen.—The extraordinary conduct of the pointsman, who absconded the moment after the late fatal collision (caused by his negligence) had occurred at the Willesden Junction, and who has not since been heard of, appears to have influenced the decision of the Coroner's jury, who at the adjourned inquest, held on the 3rd August ult., found a verdict of "Wilful Murder" against the pointsman; the Coroner (Mr. Wakley) remarking, "there never was an accident in the world which was proved more clearly to have depended on one person." The jury appended to their verdict a strong recommendation to the company to appoint an extra man to work (exclusively) the points, and another to attend to the telegraph; blaming likewise the manager of the North London Railway for the irregular mode of dispatching the Kew trains.

Railway and Canal Legislation.—The special report of the Select Committee of the Commons appointed to inquire into the best method of securing the public interests, and diminishing parliamentary expenses, in reference to railway and canal legislation, appears to afford but little prospect of material or beneficial change in the practice as at present established, the principal alterations proposed being: Committees to continue their sittings not less than five hours each day; committees of the House of Commons to have the power of examining witnesses on oath; and that the form annexed to the standing orders with regard to notices to landowners and occupiers be altered, so as to avoid the necessity of sending with the notice a description of the plan and section. The main grievances really complained of, namely, the excessive fees to counsel, unnecessary delays in forwarding Bills through the various parliamentary stages, the needless multiplication of forms, notices, &c., &c., remain unremedied.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Gold and Silver Watch-cases.—During the year ending the 30th April last, 24,870 gold and 83,614 silver watch-cases passed the Assay Office, Goldsmiths' Hall, London; and 4,189 gold, and 6,824½ silver, were marked at the Chester Hall to the 5th of July, 1858. At Birmingham, 52 gold watch-cases were marked between June, 1857, and July, 1858; and 23,926 oz. weight of silver cases.

The Nelson Column in Trafalgar Square bids fair, at last, to be completed, a vote of £6,000 having been granted by the House of Commons expressly for the works of this hitherto all but slighted national memorial.

The National Gallery.—According to the *Observer*, the Government have resolved to bring forward a full and comprehensive plan, next year, for providing in Trafalgar-square, and on the entire site of the present erection, a building worthy of the nation, and of the purposes for which it will be designed—that of a truly "National Gallery."

Telegraph, Railway, and Post Office Badges.—The Post Office Clerks in Prussia are obliged to wear uniform in the streets, and the Prussian Government now intends to impose the same uniform on the *employés* of railways and telegraphs. To distinguish, however, these three classes of functionaries, those of the Post Office are to have on their caps a *horn*, those of the Railways a *wheel*, and those of the Telegraph an *arrow*.

Enamelling (New Process).—An inhabitant of Limoges, M. Ruben, has discovered a new process of enamelling, which, in the opinion of competent judges, gives great hopes that the mode of working employed by the ancient masters (the Noels, Noualhiers, Pènicauds, Nardons, Jehans, Courtois, &c., &c.) will no longer be a secret for the moderns. A specimen of the new process was exhibited amongst the collection of enamels—the great art and glory of Limoges, displayed at the late Exhibition there, patronised by Prince Napoleon. Connoisseurs whose judgment in such matters may be relied on do not hesitate to say, that this invention will effect a *nouvelle renaissance* in the art of enamelling.

The Cotton-spinning Factory of Messrs. Stevenson and Sons, at Crosslie, 6 miles to the west of Paisley, was on Sunday afternoon (25th July ult.) destroyed by fire. The number of spindles in the mill was 28,000, and the machinery, exclusive of the building, was worth upwards of £20,000.

Patents.—In 1857, 3,200 applications were made for provisional protection, and the number of patents passed thereon was 2,028. 1,976 specifications were filed, and 1,172 of the applications lapsed on forfeit. 1,474 applications were made in the first six months of the present year. The income of the Patent Office, in 1857, was £99,029, and the expenses left a surplus of £6,005.

Solid Parquet Floors, for halls and reception-rooms, or as borders for carpets, chancels of churches, staircases, and panelling, a comparatively novel branch of manufacture, in this country at least, have lately been introduced, we believe with considerable success, into first-class buildings. Parquetted flooring, occasionally of exquisite design and make, has been long in almost general demand on the continent, but its use has hitherto in England been very restricted. The floors of Buckingham Palace are, we believe, of the description termed *parqueté*, but on the old system of joiner's work.

Metropolitan Sewers.—Between the 1st January, 1856, and the 31st July, 1857, the Metropolitan Commissioners of Sewers expended, in the construction of brick sewers and openings for the various parishes, £40,491. The cost of repairs to sewers was £4,612; and of flushing, cleansing, and carterage, during the same period, £9,436.

Smoke Prevention in Kilns, Furnaces, &c.—A new system of firing kilns, &c., so as to avoid the production of smoke, and consequent discolouration of material, in processes (porcelain-burning, for instance) wherein clearness of flame is required, has been invented in France by M. Bordone, who was some time since employed by the French Admiralty to devise a means to prevent the emission of smoke in the floating-batteries intended to act before Cronstadt. The first practical application of the new system of firing has been made to a kiln in the pottery works of M. Alluaud, of Limoges, where the smoke-consuming furnace in question has been in constant work for the last fifteen months, with complete success. A longitudinal section taken through the centre of the furnace (in this case, of the ordinary construction) gives that of a triangle, in which the furnace-bars are arranged in gradation along the line of the longest side, the ash-box occupying the base, and the opening the side. The fuel is fed at top, which is therefore kept constantly closed against the admission of air. The opening is provided with fine gauze, which divides the air into currents, and slightly warms it, so that no air is ever admitted to the top of the fuel, but is compelled to pass through it; consequently, when once lighted, no smoke can be generated, no loss of calorie can ensue from opening furnace-doors for stoking or charging, and the consumption is as perfect as may be. The whole of the furnace is constantly exposed to view. As the fuel is consumed, or clinkers formed on the lower bars only, the fuel falls naturally from the upper to the lower bars, to be replaced by fresh fuel from the source of supply. In addition to the prevention of smoke, so hurtful in firing the ware in a porcelain pottery-kiln, the advantages of the new system are said to be a great economy of time in the firing, a saving of 20 per cent. in the quantity of fuel, and, above all, a superior degree of purity and whiteness in the goods, as well as greater perfection of shape; the last effect arising very possibly from the greater steadiness and equality of the heat.

The New French Diving Apparatus (the *Schaphandre, i.e., man-boat*) mentioned in our last month's "Notes and Novelties," or rather a modification of it, combined with a floating contrivance, has been introduced by the French Government into the coral fisheries along the coast of Algiers. The new floating apparatus enables the diver (or technically, "coral dredger") to cull the choicest branches of the much-prized marine production without, as is the case in the old method, destroying the future harvest by indiscriminate raking.

Completion of the Nelson Monument in Trafalgar Square.—It was on the motion of Admiral Walcott, and on the estimate of Mr. Milnes, the Sculptor, that the House of Commons voted the sum of £6,000, for the completion of the four corners of the pediment of the column, by four colossal figures of lions. The name of the sculptor to whom the work is to be entrusted has not yet transpired. The lions are to be in granite, each 20 ft. long by 9 ft. in height.

New Stereoscope.—M. d'Almeida has communicated to the Paris Academy of Sciences an interesting modification of the ordinary stereoscope. The picture, in relief, is visible to several persons at a time, and at a distance of many feet. Two stereoscopic images are reflected simultaneously on a screen; as they are not identical, but only similar, the outlines of the one will intersect those of the other, and in order to obviate the consequent confusion, each eye must be made to see only one of the images. For this purpose the luminous rays from each image are made to pass through a glass of a different colour, one red and the other green, whereby one of the images will be reflected on the screen in red, and the other in green. The observers' eyes are provided with glasses of the above-mentioned colours: the eye covered with a green glass will only see the green image, while the other will only be visible to the eye protected by a red glass. The result is that the figure appears in relief. M. d'Almeida proposes another plan, in which both images are uncoloured, and each eye is made to perceive one image only, by rapidly intercepting the other from view by means of a revolving piece of pasteboard, cut so as only to cover one of the images at a time, at each half revolution. As soon as the rotary motion acquires sufficient rapidity, the figures appear in relief.

RAILWAYS, &c.

Railway Competition.—The respective chairmen of the London and North-Western, the Midland, the Great Northern, and, it is said, of the Great Western and North-Eastern, have recently met to devise a plan to put an end to vexatious railway competition, and allow the Companies to join in a common mode of action, as to fares, &c., for the peace and advantage of all.

The Great Metropolitan Railway—Farringdon Street to King's Cross, &c.—This much talked of undertaking—namely, to construct a railway to pass through the heart of the city, and thus improve the business facilities of the metropolis, and including (originally) the project of a tunnel under Coldbath Fields Prison—appears now to be in a fair way to be revived. At a Court of Common Council, held 29th July ult., at Guildhall

the Lord Mayor presiding, the Report of the City Improvement Committee, recommending effective support of this proposed railway, was unanimously adopted. The Act of Parliament already obtained for its construction was not, as was at one time intended, to be suffered to lapse for non-compliance with its conditions, the most material of them being, that the usual notices should be given before the 7th August, 1858. It was announced that, in order to keep the Act on foot, these notices had, within the last few days, been given, and that there was every prospect of this important undertaking being speedily resumed, and with the concurrence of the great railway companies.

"COW CATCHING" ON THE MIDLAND RAILWAY.—The village of Breadsall, about 2 miles from Derby, on the north branch of the Midland, has recently been the scene of a novel railway catastrophe. At this point there is a crossing by a road over the line; a goods train having just passed, the gatekeeper had opened the gates for the passage over of a drove of cows, sixteen in number, that were crossing to be milked, when a coal train, from Staveley to Peterborough, unobserved until then, unexpectedly came up, and dashed among the drove. Five of the cows were instantly killed. One of them was caught in the back by the life-preserver in front of the engine, and conveyed in that position at least half a mile in the direction of Derby. Three others were caught by the engine, and forced off the line and through the gate, one of them being crushed to death; the other two were scarcely injured, and were able to walk to the adjacent farm.

ON THE NEW YORK AND ERIE RAILROAD a fatal accident, by which six persons were instantly killed and forty more wounded, occurred on the 15th July ult. The night express train encountered a broken rail 5 miles from Port Jervis, when two cars were thrown off the track down an embankment which, at this point, is nearly 30 ft. high and very steep.

A COLLISION also occurred on Jackson Railroad, on the 16th July ult., with a mail train, by which many persons were injured.

AN ACCIDENT AT THE WILLESDEN JUNCTION occurred (26th July) to the Euston train, which, on leaving the latter station, was, by the neglect of the pointsman, turned off the main line on to the North and South Western branch line, and came into collision with some coal trucks. Engine-driver killed, and several of the carriages thrown off the rails. Passengers, except one, escaped injury.

RENNES TO BREST.—The Council-General of the Ponts-et-Chaussées (bridges and roads) have at length, after much deliberation, unanimously decided that this railway shall be carried along the coast, in preference to the line proposed through the interior of the country.

THE TEHUANTEPEC TRANSIT ROUTE is to be opened in October, when a mail-service will be established from the West Coast of Mexico to California.

THE HERNE BAY and FAVERSHAM Railway is to be commenced immediately, and is expected to be completed within six months. The contract is taken by Messrs. Peto and Crampton.

MILAN AND VENICE.—"Pleasure trains," as they are called in Italy, lately commenced running on this line. The consequent fraternization of Venetians with Milanese having aroused the jealous misgivings of the police, it has been deemed prudent, after the first experiment, authoritatively to put a stop to them.

GRAND TRUNK RAILWAY OF CANADA, CALIFORNIA, AND BRITISH COLUMBIA.—Arrangements are in progress by which passengers will be conveyed for one payment from Europe, *viâ* the Grand Trunk, to Memphis, in the state of Tennessee, and thence by the United States overland route to San Francisco, at which point a line of steamers is to be established to connect California with British Columbia.

PORTUGUESE RAILWAYS.—Lisbon, August 2nd.—An arrangement has been entered into between the Portuguese Government and Sir Morton Peto for the completion of the 124 kilometres of railway between Lisbon and Thomar in two years, and for the construction of another 160 kilometres, from Oporto to Coimbra and Pombal, in three years.

THE VICTORIA STATION AND PIMLICO RAILWAY, which will extend the advantages of railway conveyance into the heart of the west-end of London, is to be commenced without delay; the Victoria Company being under an engagement with that of the London, Brighton and South-Coast that the works shall be completed within two years.

THE PORTSMOUTH RAILWAY COMPANY, after a short parliamentary contest with the Brighton and the South-West Companies, have obtained an Act for constructing a line parallel with the first-named company's railway from Havant to Hilsea Fort and to Cosham, and for running over and using the Brighton Company's line between these points, but without the privilege sought of using the Portsmouth station.

BUSIGNY TO SOMMAIN.—Branch of the Northern of France (50 kilometres), and uniting Cambrai to the general system. This line has just been opened for traffic.

THE BUBWITH VIADUCT on the SELBY AND MARKET-WEIGHTON RAILWAY was, on the 2nd August ult., totally destroyed by fire. Near the Bubwith station, the railway crosses the river Derwent by an iron bridge, and thence passes over a tract of marshy land by means of a viaduct 300 yards long, and constructed principally of wood. The viaduct had only recently been tarred, and a burning cinder from a passing engine falling upon this inflammable substance, caused, it is supposed, the disaster. Between 12 and 1 o'clock in the morning, fire was observed on the viaduct, the alarm was given by the inhabitants of a farm-house hard by, and a telegram forwarded to York for the fire-engines, on the arrival of which, however, the viaduct was in a blaze from end to end. To save the structure was impossible, and efforts were therefore directed towards severing the communication of the viaduct at each end. This was eventually effected, immediately after which the viaduct fell with a tremendous crash, and presented a vast heap of smouldering ruins.

EASTERN OF BENGAL.—The Directors state, in their recent report, that every effort will be made to complete the whole line by the beginning of 1861. The line (108 miles in length) which is first to be constructed is to run from Calcutta to the river Ganges, at Kooshtee, and will form part of the shortest route to Darjeeling.

RAILWAY THEATRICALS.—In our "Notes and Novelties" for July last, we had occasion to notice the fitting up of an *Oratory* in a railway carriage for His Holiness the Pope. We have now to record a somewhat different event—the "inauguration" of a railway-station *Theatre*. A train appropriated to journalists left Paris on Wednesday morning (4th Aug. ult.), at half-past 5, for Cherbourg. Some *artistes* (players) of Paris, who were invited at a short notice by the Western Railway Company, and conceived the idea of *forming a theatre in the railway station*, went by the same train. Amongst them were Mmes. Doche and Dupuis, M. Derudda, the Danish Dancers, and the best performers of the Theatre Deburau.

THE GREAT WESTERN RAILWAY COMPANY have at length arrived at a total suspension of dividend on the ordinary stock, according to the official notification put forward by the Directors 7th August ult.

CAPE TOWN RAILWAY AND DOCK COMPANY.—This line is to be carried out according to the survey lately made by the Company's Engineer, Mr. Brounger, and will be commenced without delay, as the working sections are ready. The contract of the Company with the Colonial Government is "for the construction of a railway between Cape Town and Wellington, on the basis of a guarantee of a minimum rate of interest of £6 per per cent. for fifty years from the opening of the line."

THE GAUGE OF THE INDIAN RAILWAYS is fixed by the East India Company at 5 ft. 6 in., and that adopted for the EASTERN BOMBAY line will be uniform with the other railways of the country.

THE PACIFIC RAILROAD.—The Editor of the "New York Herald," of 19th July ult., twits his American readers with the remark that whilst they (the Americans) are making the question of a railroad to the Pacific a political one, the enterprising Britishers will be getting up an English company, with an immense capital paid in, "to give vitality to the idea." "Already their surveyors are in the field, mapping out a line from the western shores of Lake Superior, through the territories of the Hudson's Bay Company, to Vancouver's Island; and to this enterprise the recent discoveries of gold on Frazer's River will give a fresh impetus. The *Leviathan* is to run to Portland (?), as being the nearest suitable port to Canada. From Portland there is a splendid line of railroad to Montreal. The Grand Trunk Line extends across the province, and with it will be connected the PACIFIC LINE. Thus the trade of the great East will have to pass through British possessions, and thus they will secure to themselves the monopoly of that magnificent commerce which it has been the aim and object of all powerful nations, ancient and modern, to obtain."

EDEN VALLEY RAILWAY.—The first sod of this line was cut, 3rd August ult., at Appleby, by the Right Hon. Lord Brougham and Vaux. It forms a branch from the South Durham and Lancashire Union Railway at Kirkby Stephen.

THE CHERBOURG RAILWAY, connecting the military port of Cherbourg with Paris, was inaugurated on the 4th August ult., with great pomp and ceremony, by the Emperor of the French in person. It is, in point of fact, the Havre line as far as Mantes—57 kilometres from Paris. The Imperial State Carriage, or "Salon," built expressly for the occasion by the Orleans Railway Company, was fitted up with blue silk drapery and mirrors. In the centre of the "salon" was a magnificent gilt table, on which rested a bouquet of choice flowers. The central carriage communicated with an open waggon and a refreshment-room, decorated in white and gold. The carriages were designed by M. D'Ivry. Messrs. Brassey and Lock, engineers and contractors of the Cherbourg Railway, accompanied the Imperial party.

A SERIOUS RAILWAY ACCIDENT occurred (5th August ult.) at Gartsherrie, in consequence of a large excursion train for Stirling, containing about 1,100 Sabbath-scholars and teachers, running into a mineral train at a crossing. The engine was pitched off the line, and about 60 persons were injured.

GREAT NORTHERN AND WESTERN OF IRELAND.—A contract has been let for the construction and completion of the line from Athlone to Roscommon by the end of the summer of 1859, and to Castlerea in the spring following. The line is to be single, but having over-bridges, culverts, and station works, for a double line. Estimated cost, £5,000 per mile; or total, £207,750.

LONDON AND NORTH WESTERN.—The WORKING STOCK on this line consists (August, 1858) of 773 locomotive engines, 762 tenders, 1 state-carriage, 695 first-class mails and composite carriages, 561 second-class, and 425 third-class carriages, 32 post offices and tenders, 313 horse boxes, 259 carriage trucks, 267 guards', break, and parcel vans, 31 trucks and carts, 10,888 goods waggons, 1,262 cattle waggons, 279 sheep vans, 1,382 coke waggons, 27 trucks, 8,500 sheets, and 268 horses. The total cost of the working stock, including moveable machinery, tools, &c., is £3,065,567.

RAILWAY TRAFFIC of the United Kingdom.—During the half year ending 31st December, 1857, there travelled over all the railways in the United Kingdom (together upwards of 9,000 miles), 75,834,914 passengers, against 71,091,075 in corresponding half-year of 1856. Of these, 10,029,700 were 1st class, 22,789,685½ 2nd class, 12,909,457 3rd class, and 30,096,172 "Parliamentarians." Charge was made for 7,315 tons of luggage, 4,464,650 parcels, 31,170 carriages, 121,323 horses, and 178,205 dogs. Total number of miles travelled by all classes of passengers, 1,046,231,126. Number of passenger-trains, 1,029,526, and of goods-trains 577,128. 12,440,616 tons of general merchandise were conveyed during the half year, besides 1,153,959 heads of cattle, 4,167,423 sheep, and 788,277 pigs. Total receipts for passengers (all classes), £5,883,907, plus £4,098 for "excess fares;" for luggage, horses, carriages, and dogs, £456,152; for mails, £229,323; for general merchandise, &c., £3,875,178; for coals and minerals, £2,049,992; and for live stock, £254,047. Gross receipts from all sources of traffic, £12,712,700 (nearly the same amount as in 1856).

AUSTRALIAN LINES — THE GEELONG AND MELBOURNE. — The negotiations between this Company and the Colonial Government for the sale and purchase of this line at a price to be determined by Committee of the House of Assembly, are still pending.

STATISTICS OF THE CHERBOURG RAILWAY.—The section from Mantes to Caen was commenced in 1853: completed from Mantes to Lisieux in July, 1855; from Lisieux to Caen in December, 1855. Remainder (from Caen to Cherbourg) finished in 1858. Period of entire construction, five years. There are 70 bridges across rivers, and 310 roads are carried across it by arched viaducts. Number of stations, 31. Measurement of the excavations and embankments on the line, 20,000,000 cubic yards. Engineers, Messrs. Locke and Brassey.

A FATAL COLLISION, attended with the loss of twelve lives and frightful injury to many others, occurred (23rd August ult.) near the Brierley Hill Station on the Oxford, Worcester, and Wolverhampton line. Three carriages of an excursion train becoming detached, through the snapping of the coupling-chain, from the main body, and descending backwards down an incline, came in contact with another train coming from Worcester.

TELEGRAPH ENGINEERING, &c.

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY state, in their half-yearly report, that the traffic between this country and the Continent has increased to so great an extent that, with the concurrence of the Government of the Netherlands, it has been determined to lay down an additional cable to Holland. Lines are to be carried up Holborn and into the Borough for the greater accommodation of the public.

THE EXTENSION FROM TRURO TO PENZANCE (by the same Company) has, during the course of the last half-year, been completed.

WEYMOUTH AND THE CHANNEL ISLANDS.—Telegraphic communication between these places is in active course of completion by an independent company. The line is to be worked by the International (by special arrangement), the latter company having subscribed to the undertaking £4,200, the whole capital being £30,000, having a guarantee of 6 per cent. from Government.

SUBMARINE CABLE FROM CAPE HELLAS TO ALEXANDRIA.—Messrs. Newall and Co. have taken a contract with the Turkish Government for laying down the cable on this line, a concession for which was obtained two years ago by Messrs. Gisborne, but not acted upon. The original concession was for a line from Cape Hellas, by Scio and Rhodes, being the straightest line; but lately the Porte has been asked, and has consented, to change this route, and allow Candia instead of Rhodes to be taken as a station for landing the cables, the object of this alteration being to bring this line by Candia into connection with the two Mediterranean lines, and so complete the communication from Europe to Alexandria.

EUROPE TO ALEXANDRIA *viâ* CONSTANTINOPLE.—The Turkish Government intends to connect CAPE HELLAS with CONSTANTINOPLE by telegraph, so that if the Cape Hellas to Alexandria be completed, there will be a third telegraph line from Alexandria to Europe *viâ* Constantinople.

THE ATLANTIC TELEGRAPH BILL.—In the House of Lords (26th July ult.), the third reading of this Bill was negatived without a division, on the ground that the original agreement had not been carried out as was intended by Parliament.

TELEGRAPHIC COMMUNICATION WITH INDIA.—The Government have officially announced that various projects are under consideration: among others, one for laying a

submarine cable from the southern coast of England to Gibraltar, from Gibraltar to Malta, and thence to Alexandria, so that the whole line may be under English control, but that this is a subsidiary project. That under all circumstances, telegraphic communication between London, Bombay, and Calcutta, will be established.

Constantinople and Bussorah.—This line is to be made by an English company, which has obtained the consent and support of the Ottoman Government. Between Constantinople and Mosul no difficulties (arising from the attacks of hostile Arabs) seem to exist. The danger lies between Mosul and Bagdad, from the latter of which places it is intended to carry the telegraph in the bed of the Tigris to Bussorah, and thence by a submarine cable, through the Persian Gulf, to Kurrachee, the route by the Persian Gulf being considered preferable to that by the Red Sea; the depth of water in the latter being very various, and its bed full of coral-reefs, none of which difficulties were presented by the Persian Gulf, where there are no inequalities of bottom, and no coral reefs; and the Gulf being studded with islands, on which, as they are under the authority of our ally, the Imaum of Muscat, we may easily establish repeating-stations, and on which the telegraph may be carried by poles—an advantage we do not possess in the Red Sea.—(Official communication to the House of Lords, 30th July ult.)

Alexandria to Aden.—The Sultan has granted to England the right to lay down an electric telegraph from Alexandria to Aden, which will subsequently be extended to India.

Simultaneously with the above it is announced (2nd August ult.), that an agreement has been concluded with the Treasury and the Red Sea Telegraph Company for the establishment of a telegraphic line from Alexandria to Aden, down the Red Sea, and thence to Kurrachee, following the line of coasts of South Arabia. The Government guarantee is to run for 50 years certain. England, therefore, will now have a line of her own, independent of the control of any foreign government, and following the route which our mails and trade have long followed; and where we can protect the few stations not actually on our own territory from our native element, the sea—the passage across Egypt forming the only exception. The contract with Messrs. Newall for the requisite submarine cables, to be laid down at their own risk, has been completed.

Channel Islands Telegraph.—The steamer *Resolute* sailed, 30th July ult., from Liverpool, for St. Peter's, Guernsey, to be employed by the Telegraph Company in laying down their cable between the Islands of the British Channel. The expedition consists of several vessels, and will shortly leave St. Peter's for the purpose of sinking the cable.

Europe and Alexandria.—The line to which we have before alluded, between Alexandria and Aden, is about half the entire distance, but the arrangements for the establishment of a telegraph between Europe and Alexandria have also been completed, and the line will be laid down this autumn.—*Prospectus of Red Sea and Indian Telegraph Company, recently published.*

The Atlantic Cable.—Early in the morning of 6th August ult. the *Agamemnon* arrived off Douglas Head with her end of the electric cable, and communication between the two vessels being complete, a preconcerted telegraph signal announced that the *Niagara* had at the same time reached Trinity Bay, Newfoundland. The Valentia end of the cable was landed safely close by the Pier at Knightstown on the afternoon of the same day. The end of the cable was connected with the Company's station, and the signals of alternate currents, in opposite directions, continued throughout the cable. The currents from Newfoundland were very good, giving deflections of 61 on either side of the galvanometer. The line is expected to be opened to the public in the course of a month, when the line overland to Placentia, Newfoundland, and other arrangements, shall have been completed.

Electric Telegraph Extension.—Workmen are now (August 10th) busily engaged in extending the wires of the Electric Telegraph from Lothbury to Regent-street. Two new stations, it appears, are to be established on the route—one at the New Branch Post Office at the corner of Southampton-street, High Holborn; and the other at the Branch situate in Old Cavendish-street, Oxford-street, near to the Court House, Marylebone-lane.

The whole distance from Trinity Bay, Newfoundland, to Valentia, is about 1,650 nautical miles, and this has been covered by 2,022 miles of cable. The "slack," therefore, is just 372 miles, or about 22½ per cent.

The Channel Islands Telegraph Cable was successfully laid on the 6th August ult., when electric communication between Southampton and Alderney was established. The line is now in practical operation.

An European and Indian Junction Telegraph Company is on foot.

An "Inaugurating Message" was sent 23rd August ult. through the Atlantic Telegraph Cable, "from Her Majesty the Queen of Great Britain to His Excellency the President of the United States," congratulating the President upon the successful completion of the great undertaking. The President, in reply, returned a suitable message, numbering, with the address, 143 words, and occupying two hours in its passage through the cable, including several "repeats" and corrections.—[The mention of "repeats and corrections" reminds us of the comparatively slow advances which have been made hitherto in the mode of transmitting electro-telegraphic signals. It is not stated what system of telegraphing was employed on the occasion.—Ed.]

Red Sea Telegraph Line.—The stations and their distances from each other are as follows:—

From Suez to Cosseer	260 miles
,, Cosseer to Jeddah	400 ,,
,, Jeddah to Camara	430 ,,
,, Camara to Aden	280 ,,

completing the first section of the line. It is proposed to continue it hereafter—

From Aden to Ras Sharman	325 miles
,, Ras Sharman to the Kouria Mouria Islands	420 ,,
,, Kouria Mouria to Ras-el-Had	395 ,,
,, Ras-el-Had to Kurrachee	430 ,,

The Successful Laying of the Transatlantic Telegraph has been the occasion of extraordinary rejoicing, and even of wild excitement, throughout America. The ringing of bells, firing of guns, and other demonstrations of the "feeling of glorification," seem to have been the orders of the day at Albany, Utica, Boston, Washington, and, indeed, almost everywhere. Although in this country the feelings of exultation at the final success of the gigantic undertaking may have been less energetic and demonstrative in their expression, the sentiment of pride in this great scientific step in advance is not the less general and sincere.

The First Message transmitted by the Atlantic Telegraph has been the intelligence from Newfoundland (21st August ult.) of a collision at sea between the steamers *Europa* and *Arabia*, off Cape Race, on the 14th ult. The message asking Newfoundland for further particulars (of the first announcement) was dispatched from London at 5 o'clock in the evening of the 20th August ult., and the reply was received back from Newfoundland at 7·30 p.m.

Great "Russian Telegraph Line."—According to New York intelligence, Russia intends forming a stupendous telegraph line, namely, from St. Petersburg to the Russian possessions in North America, and thence to San Francisco. Its course is to be from St. Petersburg to Moscow, thence across the Ural Mountains into Asia, passing through Irkutsk to the Sea of Okhotsk, and thence from Kamtschatka across the sea to Cook's Inlet, in Russian America. This line, by a connexion with the river Amour and Mantchouria, will bring St. Petersburg and Pekin into direct communication.

MILITARY ENGINEERING, &c.

An Indian Fortress (Gwalior).—Somerset Grove, Esq., late Colonel of the Gwalior Contingent, says: "The fortress is 1¾ miles long, and 300 yards broad, tapering at the end to 70 or 80 yards. It runs nearly north and south; is 600 ft. high, of solid rock, on the top of which is a simple stone wall, about 10 ft. high. The only approaches to it are by the gate at the foot of the grand staircase in the Northern Town, and on the centre of the western face. In almost all other parts it is nearly perpendicular."

The "Lancaster" v. the "Enfield" Rifle.—The result of a "trial of skill," which lately took place between the non-commissioned officers of the Royal Engineers and those of the first depôt battalion at Chatham garrison, for a prize of a silver snuff-box, under the inspection of the "Instructors of Musketry" of the respective competing companies, has established the superiority of the Lancaster elliptical bored musket (the rifle used by the Engineers) over the ordinary Enfield musket, used at the School of Musketry, Hythe (in use by the troops of the line). The trial range commenced at 350 yards, afterwards extended to 600 yards, each man being supplied with twenty rounds of ball-cartridge. The average number of "points" gained by each non-commissioned officer of the Engineers was 15 out of the 20 (centre of target, distant 600 yards); that by the troops of the line 10·87. Additional trials, with analogous results, took place 4th August ult.

Turkish Ordnance.—A nine-pounder brass gun, with carriage and ammunition-waggon, which were recently landed at Woolwich Arsenal from Turkey, as a present from the Sultan to the Queen, were on the 2nd August ult. forwarded to the Tower. The gun, which is 16 ft. in length, is an excellent casting; but the carriages, as specimens of workmanship, are inferior to those manufactured for the British Artillery service.

The Monster Mortar.—The expediency of future experiments to test this huge (36-in.) mortar is under consideration of the Select Committee of Royal Artillery and other officers. The general opinion, however, in military circles appears to be, that with regard to practical utility for purposes of warfare, the experiments with this weapon hitherto have proved it to be a decided failure.

Iron Ordnance Factory at Woolwich.—The total expense of this establishment, from the 1st January, 1854, to March 31st, 1858, is returned at £130,059—viz., £60,707 for buildings, £37,500 for machinery, and £24,350 for stores. Up to March 31st last no guns or mortars had been completed, and only 10 were in process of manufacture; while 215 were vented in the Gun-boring Mill.

A New Musket, from the Imperial manufactories of Tulle and Châtellerault, is being gradually introduced into the French army. Of this musket there are two classes, but slightly differing from each other. The first has four grooves, of the same depth throughout, and equal to double the length of the barrel. Each groove, therefore, makes a half-turn. The distance to which this musket will project a ball is 600 metres (1,964 ft.). The other has four grooves like the preceding one, but is only 13½ millimètres in diameter, instead of 18½. The barrel is shorter, to compensate which the bayonet is made longer.

The last of the Ten Gun Boats ordered from Messrs. Rennie, by the East India Company, has been shipped.

Chinese Fortress.—Admiral Rigault de Genouilly has sent to the French Minister of Marine, for the museum of that Department, a plan of the Forts of the Peiho, executed by an officer of the French Fleet.

Ordnance Survey.—Her Majesty, it is expected, will shortly inspect the Ordnance Department in Southampton, where the Trigonometrical Survey of the kingdom is carried on.

A Model "Salute."—When Her Majesty Queen Victoria disembarked from the Royal yacht in the harbour of Cherbourg, she was greeted with the continued roar of nearly 3,000 guns, fired with incessant rapidity for 20 minutes, commencing the instant Her Majesty stepped from the Royal yacht and embarked in the *Fairy* for the Military Fort.

The New Government Gunpowder Works, now in course of construction and extension at Bull Point, near Devonport, were, on the 19th August ult., officially inspected by Sir John Pakington and other members of the Board of Admiralty.

The Norfolk Artillery have been ordered by the Earl of Leicester, the Lord Lieutenant of Norfolk, to assemble at Great Yarmouth on the 7th September next, for 21 days' training and exercise.

The Hampshire Military Artillery, Earl of Malmesbury, Honorary Colonel, and Colonel Burnaby, late Royal Artillery, Lieutenant Colonel Commandant, are to assemble at Gosport on the 20th September next for 21 days' training and exercise.

The Northumberland Artillery are to meet at Tynemouth on the 10th September next, for drill practice.

The Sherwood Foresters are still assembled at Newcastle and Tynemouth, and are daily out on Whitby sands, at rifle practice.

The New "Vaisseau-Belier" (literally, battering-ram vessel), said to be of Imperial invention, and in process of building at Cherbourg, has caused some sensation in the military world. It is, according to report, to be a sort of man-of-war, and intended to act by its mass and its speed combined. Something of the kind is related to have been in practice with the naval tacticians of the ancient world; but the introduction of such an element of offensive power into modern naval warfare will undoubtedly tend to impart to it an entirely new character.

Heavy-Gun Casting.—On the 28th August ult., several 68-pounder guns, cast at the Royal Standard Foundry, Woolwich Arsenal, were proved at the butt, in presence of the Committee of Royal Artillery Officers. The result was far from satisfactory. Two of the guns, under the ordinary proof, splintered and burst, scattering huge pieces of metal in all directions.

MARINE STEAM ENGINEERING, SHIPBUILDING, &c.

The "Pera" on her last trip with the India mail made a most extraordinary voyage. She left Southampton July 4th ult., and returned on the 31st—6,000 miles and five stoppages in twenty-seven days. She ran from Southampton to Gibraltar, 1,000 miles, in three days twenty-one hours; thence to Malta, another 1,000 miles, in three days twelve hours; and from Malta to Alexandria, 1,000 miles, in two days nineteen hours. Arrived at Malta from Southampton on the 12th July. Thus she ran a distance of 2,000 miles in little more than seven days.

A New Marine Steam-Engine and Boiler.—The "New York Tribune" reports favourably of a trial trip recently made on the Hudson river, on board the steam-boat *John Gowan*, which was propelled by a steam-engine and boiler the invention of a gentleman of that name. The boat is propelled by an ordinary beam-engine, 8 ft. stroke, 36 in. diameter, and by a high-pressure horizontal engine, 2 ft. stroke, 34 in. diameter. The beam-engine works at from 30 lbs. to 35 lbs., and is condensing. The high-pressure engine works at from 80 lbs. to 100 lbs.; the steam escaping from it at a pressure of 30 lbs. to 35 lbs., works the condensing-engine. Boiler tubular: the flame moves to the end of the boiler, and returning near the furnace through small tubes below the surface of the water, passes hence through two cylinder flues placed above the water into the steam.

The Royal Yacht, on its recent trip to the fêtes at Cherbourg, was delayed nearly half an hour when off the Isle of Wight, by reason of the apparently trifling circumstance of a tough piece of seaweed getting into the machinery.

Yarmouth Roads.—As many as 2,000 ships have been known to pass through Yarmouth roads in a day. There are frequently from 1,000 to 1,400 vessels of various sizes at anchor in the roads; and there is scarcely ever a gale, especially from N.N.E. or S.S.W., in which loss of life does not occur.—*Mr. Young, M.P. for Yarmouth, in House of Commons, 26th July.*

British Shipping.—In 1843 the amount of tonnage of British shipping which entered or cleared from ports or harbours of the three kingdoms was 7,180,000, and of foreign tonnage, 2,643,000, making altogether 9,824,000 tons of shipping. Last year the amount of British tonnage was 13,694,000, and of foreign 9,484,000 making a total of 23,178,000 tons. Increase, more than 130 per cent. In 1843 the amount of tonnage built in this country was 83,000, while last year it was 250,000 tons.—*Mr. Wilson, M.P., July 26, on Harbours of Refuge.*

Flamborough Head and St. Abb's Head.—The coast between these two points is officially described as the most dangerous to shipping. In five years, from 1852 to 1856 inclusive, 763 vessels were wrecked here; while between Portsmouth and Dover, only 177 vessels were wrecked in the same period. From the registers kept at the Admiralty and the Board of Trade it appears, that the same 763 wrecks involved the loss of 260 lives, while the 177 vessels wrecked involved the loss of 218 lives. As regards comparative loss of life, therefore, the southern coast has also its share of danger.

Sunken Vessels (Recovery).—According to the "Boston Transcript," the American divers at Sebastopol are at length working successfully in raising the sunken Russian fleet. A 16-gun vessel of war had been brought up in an entire state, and in the following week operations were to commence on one of the steamers. "The whole fleet," it is alleged, "will be raised this summer." [*Nous verrons.*—Ed.]

The New Steam Route to America *viâ* Galway.—The *Prince Albert* screw steamer, substituted for the new ship *American Eagle*, which it was found impossible to complete in time, as advertised, left Galway on the 27th ult. for Halifax and New York, with the mails and 172 passengers; tonnage, 2,000; original cost, £65,000; barque rigged; length, 286 ft.; beam, 38 ft.; depth, 29 ft.; propelled by 2 engines, of the aggregate of 400 H.P.; cylinders, 60 in. in diameter; inverted length of stroke, 4 ft.; her screw, worked directly, is driven at 44 revolutions per minute; Beattie's patent, outside the rudder, has 3 blades, and is 18 ft. in diameter, with a pitch of 34 ft.

Circumnavigation of the World by Steam.—The circle of steam communication will be established round the world when the Suez route is extended from Sydney to Panama, and then to America and Southampton. It has hitherto been supposed by many that the Panama route is the shortest, but a pamphlet published by the Post-office Committee shows that the Suez route, by the Island of San Diego Garcia, is 76 degrees of longitude nearer than that of Panama. Melbourne is 8 days 17 hours nearer to London by Suez than by Panama, at an average speed of 10 knots, and Sydney is 1,140 miles nearer. —*M. De Salis, at meeting of Australian Association.*

A Model Life-boat.—The Southport life-boat has, it is said, been the means of saving, on various occasions, 200 lives from wreck. Its latest exploit was during the gale on the 26th July ult., when the schooner *Mineral*, of Barrow, for Ellesmere, laden with iron, was driven ashore, and was lying sunk in the banks off Southport, with her crew lashed to the rigging. The life-boat put to sea, and succeeded in saving the crew (3 men), who had been exposed in the rigging for ten hours.

The New "Life-light," for Shipping.—The whole of the ships attending Her Majesty to Cherbourg were, by orders to that effect received from the Admiralty, by the Hon. Major Fitzmaurice, lighted with his newly-invented "life-light." Report speaks most favourably of this new invention, the effects of which are said to surpass all the hitherto-known methods of illumination—the electric light even included.

The "Royal Sovereign," 131, new screw three-decker, was (12th August ult.) taken out of Portsmouth Harbour to Stokes Bay to try her speed, which, after the usual runs up and down the measured course, with and against the tide, averaged a mean of 12¼ knots per hour.

Failure in Launch of the "Mersey," 40, screw steamer, at Chatham Dockyard, 12th August ult.—When the last dog-shore was knocked away, the huge vessel (the longest of any line-of-battle ship in the British navy) refused to move down the "ways" into the Medway. No subsequent attempts made that day could induce her to move an inch, but, Leviathan-like, she remained firm on the stocks. The reason assigned for the failure was the sinking of the ground at the head of the slip on which the *Mersey* was built, which carried the "ways" down with it, and destroyed the incline, and this notwithstanding the thick layers of cement and concrete of which the bottom of the stone slip is composed. There was no other way of accounting for the unfortunate "hanging" of the ship than that there was not "cant" enough for the vessel to slide down the ways. The *Mersey* is the second of the immense screw frigates which the late Lords of the Admiralty ordered to be laid down to compete with the large war steamers lately constructed for the navy of the United States. She is half the length of the *Great Eastern.* Extreme length, 336 ft. 6 in.; length between perpendiculars, 300 ft.; of keel for tonnage, 264 ft. 5·57 in.; extreme breadth, 52 ft.; breadth for tonnage, 51 ft. 6 in.; breadth moulded, 50 ft. 8 in.; depth of hold, 19 ft. 10 in.; burden in tons, 3,726,70 94ths. Total length of engine: space, 133 ft., fitted with machinery of 1,000 H.P.—The following day, another and successful attempt was made to complete the launch. The signal was given to upwards of 100 shipwrights to commence simultaneous operations. The hydraulic presses were charged, and the rams lifted by means of wedges against the bows; in about five minutes the efforts of the workmen were crowned with success, and the *Mersey*, yielding to the overwhelming force brought against her, glided down the "ways" amidst the cheers of the spectators.

The "Simla," iron ship, built at Birkenhead, by Messrs. Peto, Brassey, and Co., was launched on the 10th August ult. 1,509 tons register, 4,000 measurement, 220 ft. in the load line, 36½ ft. beam; has 25½ ft. depth of hold. She is intended for the Calcutta trade.

The Launch of the War Steamer "Ville de Nantes," of 90 guns and 900 H.P., from her stocks in the New Arsenal Dock (7th August ult.), concluded the grand maritime *fêtes* of Cherbourg. Precisely at 6 o'clock p.m., being the time of high-water (the tide having for the first time filled the recently-opened Docks), on a signal from the Emperor, the last hawser was cut which kept the steamer on her stocks, and she glided into the water amidst tremendous shouts of "Vive l'Empereur" from at least 100,000 spectators.

The "Leviathan" ("Great Eastern"). — The Eastern Steam Navigation Company, at an extraordinary meeting held on the 10th August ult., have decided that the *Great Eastern* steamship shall be put up to sale by public auction, in preference to a scheme proposed to establish a Limited Liability Company, to fit out the ship for sea, and provide working capital.

GAS ENGINEERING—(HOME AND FOREIGN).

Price of Gas Reduced.—The Banff Gas Company have reduced the rate of their gas per 1,000 feet from 10s. to 9s.

Parisian Gas Company.—The receipts in the month of June, 1858, were 704,396 fr. ·06 centimes against 673,512 fr. 16 centimes, in corresponding month of 1857, showing an increase of 66,883 fr. 90 centimes, or say 10·49 per cent. Total receipts for the first six months of 1858, 7,047,231 fr. 82 centimes, against 6,244,852 fr. 6·4 centimes, in corresponding period of 1857. Increase, 802,379 fr. 18 centimes, or say 12·84 per cent.

Rome.—The enterprise for lighting up the ancient Metropolis of the World with gas is favorably progressing. The Pope has conferred on the Engineer of the Company (an Englishman, Mr. James Shepherd) the honour of Roman Knighthood, by creating him "Chevalier of the Order of Pio Nino."

HYDRAULIC ENGINEERING, &c.

Water-power Applied to Organs.—The bellows of Carlyle Cathedral are set in motion by a modification of hydraulic pressure, invented and patented by Mr. H. Willis. The water is collected in two cisterns or tanks, placed in the roof over the south aisle, and is drawn from the reservoir supplying the town. From these cisterns the water passes down a pipe into two cylinders, like those of a steam engine, and standing in a hole. Exactly over these cylinders are two feeders, made like those of the organ-bellows, each having a diaphragm, or middle-leaf, which is moved up and down by means of the pistons. Attached to these leaves are two rods, which pass down to two large taps. The reciprocating motion is obtained by one cylinder operating upon the tap of the other, and the blast of air obtained by these feeders is continuous, but varied by a steam equilibrium throttle-valve, which the reservoir of the bellows closes as it becomes thoroughly inflated. The engine is under the immediate control of the organist by suitable gearing leading to valves in the cistern.

Miller's Patent "Hydraulic Purchase" is to be applied as the hauling-up power in the slip-dock, now constructing at Glasgow, for the Pacha of Egypt. It is a most massive piece of machinery. The hydraulic cylinder has just been cast, and weighs 17 tons. The inventor is a member of the firm of Bell and Miller, civil engineers, of Glasgow.

WATER SUPPLY—(METROPOLITAN AND PROVINCIAL).

East London Waterworks. — The whole of the supply of the East London Waterworks is taken from the river Lea before the admission of any contaminations from the suburban parishes. To ensure this result, extensive works were some years since executed by the Company, and are now in operation.

Bath. — Public Cisterns and Fountains, on the plan adopted at Liverpool and Birmingham, are about to be constructed.

Chester.—Peter Eaton, Esq., the late mayor of this ancient city, has presented to the public a beautiful granite fountain.

Other Cities and Towns will, we trust, emulate the munificence of Mr. Melly, the Liverpool merchant, who first set the benevolent example of sympathy with his poorer fellow-townsmen by erecting, at his own expense, the most useful of all memorials—a large number of public drinking fountains.

Scotland — Glasgow.—The Water of Loch Katrine is in process of being introduced into the City of Glasgow.

Aberdeen.—The water of the river Dee supplies the inhabitants of Aberdeen.

Stirling.—The source of the water employed at Stirling is the adjoining hills, the supply being brought in by the town on the security of the water-rates.

Analysis of Metropolitan (as compared with some Provincial) Water.—Result of examination during the month of July by Dr. Robert Dundas Thompson, F.R.S., of St. Thomas's Hospital. The impurity is indicated in grains or degress per gallon.

	Total Impurity.	Organic Impurity.
	Grs. or Degs.	Grs. or Degs.
Distilled Water	0· 0	0· 0
Loch Katrine	2·15	0·80
Dee, Aberdeen	4·00	1·80
Stirling Water-supply	5·29	1·10
Thames Companies:—		
Chelsea	16·52	1·40
Southwark	17·12	2·12
Lambeth	19·20	2·00
Grand Junction	16·08	·84
West Middlesex	15·24	1·28
Other Companies:—		
New River	18·20	1·08
East London	19·20	1·48
Kent	22·08	2·40

Paris Supply.—A project, it appears, is seriously entertained of doing away with the old system of water supply in Paris, by bringing pure spring water from Champagne, in an elevated aqueduct, which will convey the water into cisterns on the top of the houses, whence it will descend by pipes.

AGRICULTURAL MACHINERY, &c.

Steam Ploughs.—At the Yorkshire Agricultural Show, held at Northallerton, on the 3rd August ult., Fowler's Steam Plough, or, more properly speaking, a plough drawn by a portable steam-engine, performed its work in an admirable manner, and was perhaps the best exhibition on the ground of what has been accomplished by modern science in furtherance of agriculture.

Bray's Traction Engine.—The employment of steam for locomotive purposes on common roads is again, after the lapse of some five-and-twenty years of neglect—we had almost said of oblivion, likely to occupy the attention of engineers and capitalists. Recently, experiments have been made with a traction-engine of great power, which proceeded from the factory of Messrs. Maudslay and Field, along the Westminster Road, to their wharf, close to Westminster Bridge, at a slow but regular pace, and apparently under the complete control of the conductor.

Steam Threshing.—*A fatal boiler explosion* (one man killed) occurred 20th August ult., with a steam-threshing machine, at Daybrook, near Nottingham. On the inquest it was stated in evidence that the explosion resulted from the engineman (himself severely injured) leaving the machine without closing the damper, or easing the safety-valve, thus causing the steam to generate rapidly and to burst the boiler. Large pieces of metal from the machine were thrown to a distance of 200 yards, and the fly-wheel was picked up 100 yards from the engine. Inquest adjourned.

HARBOURS, DOCKS, CANALS, &c.

The Pacha's Slip Dock.—The largest slip dock that has yet been made is in course of construction at the works of Messrs. Morton, of Glasgow. It is to be capable of taking up ships of war, and steam ships of 3,000 tons register, and is to be erected at Alexandria for the Pacha of Egypt.

The Great Rowley-hill Canal Tunnel.—The most important event of the month, in connection with the coal trade of South Staffordshire and East Worcestershire, has been the opening of the great tunnel under the Rowley-hills, executed by the Birmingham Canal Company, and forming a direct and uninterrupted communication between important mineral districts. Hitherto, the only means of communication by water between Birmingham, Wolverhampton, the East Dudley, the West Dudley, and East Worcestershire districts has been the old Dudley tunnel, as it is termed, navigable for only one boat at a time, and that only by being propelled by manual labor—a means of transit totally inadequate to the necessities of late years, greatly-increased traffic, and to the importance to the Birmingham and Dudley district of ready access to the valuable fields of ten-yard coal abounding in the neighbourhood of Netherton, Old Hill, Cradley, and Kingswinford. For remedying this deficiency, the Birmingham Canal Company projected the stupendous work just completed. The entire length of the tunnel is 3,035 yards, width 27 ft., 17 ft. of water,

a tow-path, 5 ft. wide on each side, and 16 ft. high from the water-level. The new canal and tunnel extend from Dudley Port to the Delph, where a junction is formed with the Stourbridge Canal. This magnificent work was "inaugurated" on the 20th August ult. by the Chairman of the Company (Sir George Nicholls), accompanied by the Marquis of Chandos, and upwards of 200 gentlemen connected with, or interested in, the success of the undertaking.

Thames Haven Dock.—At the half-yearly meeting of this Company, held on the 21st August ult., at the Office, Exchange Buildings, the chairman intimated that the successful issue of the undertaking was still doubtful—that at a former meeting he had stated that if they (the shareholders) could do nothing, they had better wind up the concern. A negotiation had been set on foot with parties who thought something could be done with the undertaking, but nothing had been concluded.

Harbours of Refuge.—In the House of Commons, Mr. Wilson, M.P. for Devonport, having made his promised motion for an address for the appointment of a Royal Commission on Harbours of Refuge, as recommended by the Select Committee, the same was agreed to, the Government, through Sir J. Pakington, assenting.

The Scotch Canals, financially considered, would appear to be in no very flourishing condition.

The Caledonian Canal has not realised the anticipations of its projectors. The traffic accounts show a deficiency as between income and expenditure. The annual receipts up to May 1st, 1858, were £5,560, and the payments £6,185.

The Crinan Canal also exhibits a deficiency in the annual accounts. In both instances, however, the Commissioners anticipate a more favourable result for the future.

Cape of Good Hope—Advices up to June 20.—The Local Government is about to form a habour of refuge at the Cape, by a modification of the Admiralty plan.

The Yarmouth "Britannia Pier."—This new pier, which has just been opened, although not yet quite completed, was commenced in September, 1857. It will be 753 ft. in length, 650 ft. in the water at high tide; width of pier, 24 ft.; height (from the sand beneath), about 15 or 16 ft.; depth of water at the extreme end (pier-head), 28 ft.; eleven of the bays, or arches, 20 ft. clear width; pier-head will be 60 ft. in diameter. Total cost of the erection (including Parliamentary and other expenses), about £5,000.

Canadian Canal Traffic.—A larger trade passed through the Canal Channel in 1857 than in any previous year, the tonnage being 291,751 in 1857, as compared with 280,736 in 1856; but there is a diminution in all the other canals, the figures being, for the grand total tonnage of property and vessels up and down, as follows: Welland Canal, 1856, 2,255,802; 1857, 2,049,506. St. Lawrence Canal, 1856, 1,349,577; 1857, 1,283,683. Barrington Bay Canal, 1856, 547,147; 1857, 212,171. St. Ann's Lock, 1856, 347,087; 1857, 325,801. Net revenue received from canal tolls for 1857 was £55,639, against £69,979 in 1856.

Galway and America.—Proposed Harbour, Breakwater, &c., at Galway.—A deputation, including the Lord Mayor of Dublin, and the respective High-Sheriffs of Galway, town and county, recently waited on the Lord Lieutenant to obtain a grant of £152,000 from Government for the construction of a pier and breakwater for Galway harbour, as being necessary for the accommodation of the contemplated American traffic. The large expenditure sanctioned in the cases of Dover and Alderney was adverted to by the applicants. The reply of the Lord Lieutenant was courteous, but unfavorable to the grant—at all events, for the present. The deputation, it was suggested, was somewhat premature; and they were recommended to wait till the superiority of Galway over the English ports—as far as regarded time, &c.—should be more fully demonstrated.

The New Breakwater at Cherbourg is nearly half a mile longer than that at Plymouth, and 20 feet higher out of the water at full tide. There are four powerful forts, which face not only seaward, but have batteries commanding the interior of the harbour; likewise Fort Central and the two end forts mount about 60 guns each—the fourth fort only 35 guns. All the forts are of solid granite, with their lower tiers of cannon in casemated batteries: the upper are stone embrasures. Most of the breakwater batteries carry the heaviest guns used in war, all 68 pounders, 10-inch guns and long 32's. The contrast in this respect between the French works and our own is remarkable. There is not a battery in Plymouth or Portsmouth carrying heavier metal than long 56 cwt., 32-pounders; while—especially at Portsmouth—both bastions and redoubts are armed only with short 24, or even 18, pounders.

A Capacious Dock, chiefly intended for the accommodation of the timber-trade, has been completed at the north end of Liverpool, and has been named by the Mersey Dock Board the "Canada Dock."

The New Dock in the Naval Arsenal, Cherbourg.—The inauguration of this splendid dock by the French Emperor in person, and the launch of the *Ville de Nantes*, concluded the Cherbourg fêtes. The Emperor and Empress, with their suite, including the respective Ministers of War, Marine, and Public Works, descended into the dock by a staircase made for the occasion, and covered with a handsome carpet. The Emperor then fastened in its place a plate commemorative of the important event which was about to take place, and a box containing medals and coins. The religious ceremony of the benediction of the new dock was then performed by the Bishop of Coutances. Immediately after, the filling of the dock took place. A vast dam of earth and sand had been raised at the northern entrance, very broad at the base, and tapering up at the top, all the materials being closely rammed together. On the Emperor giving a signal, and by the springing of a mine, a sufficient section of the barrier was thrown down, and the water, rushing over like a tremendous cascade, swept away the rest. The superficies of this immense reservoir exceeds 20 acres, and it will contain 2,000,000 cubic metres of water.

The Suez Canal.—Respecting this much-vexed question, Mr. Stephenson has addressed a letter to the "Austrian Gazette," in reply to Chevalier de Negrelli, engineer, in which he enters at some length into the reasons for the opinion recently given by him in the House of Commons adverse to the scheme of a ship canal through the isthmus. The proposed construction involved two classes of engineering works:—1st. The construction and proper maintenance of the canal itself. 2nd. The formation and maintenance of seaports and deep entrances to the canal, both on the Red Sea and in the Mediterranean. On the assumption as true of the early report of the French engineers who accompanied the expedition to Egypt in 1799, namely, that there existed a difference of level between the Red Sea and the Mediterranean of no less than 9·90 metres, it would have been easy to open a channel and establish a sufficient current from the Red Sea to the Mediterranean with a velocity which would keep the canal open by its scour, and maintain a clear channel, not only in the canal itself, but in the harbour in the Mediterranean. As subsequent investigation, however, had clearly established the fallacy of this assumption as to difference of level, &c., Mr. Stephenson considers such a channel as impracticable—that the project would result in the formation of "a stagnant ditch between two almost tideless seas:" in a word, would prove "abortive in itself, and ruinous to its constructors."

The New Keyham (Devonport) Harbour and Dockyard, as compared with Cherbourg.—The Keyham Harbour, when completed, will be the largest in England. It will occupy 72 acres. It has two basins with an area of 6 acres each, three large dry docks, and the usual number of storehouses and workshops, whilst that of Cherbourg occupies an area of 220 acres (*i.e.*, an area three times larger than that of Keyham). It has three basins—one containing 15 acres of water, another 16 acres, and the third containing 20 acres of water (five times the water space of Keyham). Each of them has 30 ft. of water at low tide. Along the quay walls of these basins twenty-five of the largest line-of-battle ships could be moored head and stern.

A new Lighthouse, according to intelligence from Athens, has been established on a peak of the Island of Andros. It is perceptible in a radius of 40 miles for ships passing the Cyclades to or from Constantinople.

BRIDGE.

The Railway Bridge over the Spey, in Morayshire, for the Aberdeen and Inverness Junction line (opened on the 18th August ult.), is nearly finished. For the present, passengers must cross, though without much inconvenience, there being only one change of carriages from Aberdeen to Inverness.

BOILER EXPLOSIONS.

At Newcastle-on-Tyne, on the 27th July ult., one of the large boilers in the establishment of Messrs. R. Morrison and Co., Ouseburn, suddenly burst, the explosion tearing off the roof of the shed, hurling large fragments of metal in various directions, and severely scalding eight men and boys, three of whom have since died of injuries received. The boiler was an upright cone flue, and nearly new, having been fixed up only a fortnight. It is said that the water had got low, and that cold water was pumped in while the plates were red-hot. The verdict of the coroner's jury was to the effect, that the explosion was occasioned by a want of water, and from overheating of the plates.

At the Woollen Cloth Mill of Messrs. George and James Blackburn, Little Gomersal, Yorkshire, another boiler explosion occurred, killing two men.

Safety in the Use of Steam.—In Glasgow, a new society—the Institution of Engineers in Scotland—has been formed, under the best auspices, and with the support of the Lord Provost, who has agreed to preside at a public meeting to be held (at Glasgow, we believe) on the 1st September, to establish the proposed Association, the principal object of which (identical in the main with that of the Manchester Association) is "to promote safety in the use of steam for land, marine, locomotive, and all other purposes," including amongst the objects of the Association the prevention of smoke, and the inspection of boilers and of the engines of steam-vessels. The prospectus, recently published, appeals for support to the parties using steam boilers and engines in Glasgow and the neighbouring districts, and on the river Clyde and adjoining navigations.

Improved Safety Valves.—An apparatus for preventing the explosion of steam boilers has recently been patented by Mr. Joshua Haste, of Leeds. The principal feature is the introduction of an internal or additional self-acting balance valve, which operates when the pressure of steam in the boiler slightly exceeds that at which it is intended to work. The additional valve is also brought into operation by means of a float when the water in the boiler is reduced by the generation of steam or otherwise, or when the ordinary safety valves are by any means prevented from acting. The apparatus is placed beyond the reach of the attendant, who is thereby prevented from tampering with it.

The Manchester Association for Prevention of Steam Boiler Explosions has under its observation 222 condensing engines, working at from 15 lbs. to 30 lbs. pressure; indicated H.P., 25,999; and 6·4 lbs. average consumption of fuel per H.P. per hour.

MINES, METALLURGY, &c.

Coal in Scinde.—Recent advices from India are divided on the merits of the coal lately discovered there; but the trials reported leave but little room to doubt that for locomotives and river steamers it will prove extremely useful. It can be delivered at the Port of Kurrachee at 24s. per ton, or about one half the average cost of English coal. It is, however, very sulphureous, and therefore dangerous for stowage, and unfit for long voyages.

Coal Districts of Staffordshire and Worcestershire.—Direct water communication has been established between the eastern and western parts of the coal districts, by the opening of the new Canal Tunnel under the Rowley Hills; for the details of which see "Harbours, Docks, Canals, &c."

Maryport and Carlisle.—The mineral traffic is now worked with increased facilities over a double line of rails on the line between Maryport and Wigton, more especially as regards the shipment of coal, coke, and lime, on a large scale. The directors have concluded arrangements with the Messrs. Walker, by which the whole of their coal will shortly be brought on the line at Dereham, instead of, as heretofore, the greater portion being carted to Maryport for shipment. The Messrs. Walker are now making the branch railway to connect the Lonsdale Pit with the Company's line.

Tin Mines in France.—The district of Vaulry and Cieux is productive not only of tin, but likewise of auriferous sand. At the recent Limoges Exhibition, Messrs. Destrein and Co. exhibited a plan and model of their Tin-mine, with ingots of the metal and specimens of auriferous sand from the neighbourhood in the above district.

Spanish Mines.—On occasion of the recent visit of the Queen of Spain to the mining village of Mières (*en route* for Oviedo), her Majesty paid a visit to the extensive ironworks near the town, formerly the property of a body of English shareholders known as the Asturian Mining Company, but at present under the management of M. de Grimaldi. The Queen was received by the engineers at the head of the workmen, and in answer to some questions concerning the mineral wealth of the district (known to be the richest in Spain), she was informed of the intention which existed of forming all the important companies of the neighbourhood into one amalgamated society, which would comprise the works and railway of the Duke de Rianzares, running to Gijon—a project of which she expressed her entire approval, promising it every support.

Slate Quarries.—According to the "Chester Chronicle," the quantity of slates exported at Carnarvon and Port Dinorwic during the month of May, 1858, was 7,723 tons 18 cwt., showing an increase of 555 tons 2 cwt. on the exports for the corresponding period last year. About 500 tons were conveyed by railway from the Carnarvon station in May, and four-fifths more were despatched overland from Port Dinorwic. Total, upwards of 10,000 tons per month, which is 120,000 tons per annum. These figures fairly represent the average trade.

An East Anglian Smelting, Reduction, and Coal Company is announced. The site of operations, for lead and zinc smelting and the reduction of auriferous ores, is to be near Nestor, in Cheshire.

Monster Nugget.—The latest news from Ballarat is the discovery there of the largest gold nugget yet known or heard of, and weighing 2,217 oz.

A Deep Coal-pit.—The most remarkable coal-pit, perhaps, in the world, is that in Dunkinfield. The sinking of this pit commenced in 1847, and the first shaft, of 476 yards, was completed in 5 years. The second sinking commenced in February, 1857, and was completed to the depth of 686½ yards, through the coal, in August last. The whole cost has been upwards of £100,000. The coal in this pit, it is calculated, will last 100 years; and the black mine or seam of coal now reached will last 30 years at 500 tons per day.

Wolframic Steel.—At the recent "Central of France Exhibition," held at Limoges, Messrs. Kœller and Jacob, of Vienna, exhibited several articles manufactured from a new combination of minerals (one of these being Wolfram, obtained from St. Leonard, near Limoges), and to which they have given the name of "Wolframic Steel."

A New Mine of Lead Ore has been discovered traversing Wanthwaite Crag, in the royalty of R. Marshall, Esq., of Keswick. The vein is now producing a considerable quantity of the species of lead ore (occasionally rich in silver) technically termed "argentiferous galence." A level has been carried in the vein, which promises to be very productive.

Taxes on Coal.—The City of London, which forms but a small portion of the metropolitan district, raises a tax on coal which amounts to £250,000 per annum.

An Explosion of Fire-damp (six men killed) has occurred at the Cyfing Colliery, near Ystalyfera, Glamorganshire, belonging to Mr. Walters. The accident was caused by the incautious use of a naked light in the "Crimean" pit. The air-partition, which was of brick, was blown to atoms, and the works were otherwise injured.

APPLIED CHEMISTRY, &c.

Pyrito-bituminous Schistus as a Disinfectant.—M. Bordone has lately discovered at Montgivray, in the valley of the Indre, three layers of lignite, 9 ft. thick, and separated by strata of pyrito-bituminous schistus (or slate). The lignite is used for fuel, and from the schistus are recovered bitumen, mineral oil, and sulphate of alumina. The residuum or ash is employed as a disinfectant and an absorbent of fertilising matters for the formation of an artificial manure; or the schistus is employed for a like purpose in its natural state, or after reduction to ashes. The manure is stated to contain, besides the fertilising animal matters, phosphates and carbonates of lime, sulphates of iron and alumina. The color resembles that of guano, and, while dry, emits no unpleasant odour. It keeps well, in consequence of the sulphuric acid present in the sulphate preventing the fermentation of the nitrogenous constituents, which become soluble only when in contact with moisture, as they would be in the soil, and when they would surrender up their fertilising powers to promote the growth of vegetation. As the demand for disinfectants is now on the increase, it might be desirable to ascertain the effects of the schistus upon sewsge.

Tungstic Acid.—Messrs. Kœller and Jacob, of Vienna, by the addition of Tungstic acid in the ordinary preparation of porcelain, impart to it a translucid appearance resembling marble.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 13th April, 1858.

794. G. A. H. Dean, 11, Ludgate-hill—Stereoscope's slides.

Dated 1st May, 1858.

974. J. Phymoni, Crooked-la.—Apparatus for catching fish in tidal rivers.

Dated 24th May, 1858.

1156. J. Edwards, 77, Aldermanbury, and T. Loveridge, 74, Aldermanbury—Manufacture of buttons and other fastenings for articles of dress.

Dated 5th June, 1858.

1274. W. Hooper, Mitcham, Surrey—Projectiles.

Dated 28th June, 1858.

1452. J. Luis, 1b, Welbeck-st., Cavendish-sq.—An apparatus permitting machinery working in the water of screw vessels with wells to be examined and mended.

1454. J. Morgan, Rotherhithe—Apparatus for manufacturing or spinning rope yarns or other yarns.

1456. J. C. Coombe, 10 Alfred-place, Newington-causeway, Southwark—Manufacturing manures from fecal and other matters.

1458. W. E. Newton, 66, Chancery-lane—Apparatus for making nails.

1460. B. Young and P. Brown, Spa-road, Bermondsey—Method of collecting and disposing of the sewage of towns or cities.

Dated 29th June, 1858.

1462. E. Stevens, 5 and 6, Cambridge-rd., Cambridge-heath—Cooking utensil.

1464. J. Shaw, Manchester—Conical paper bags.

1466. H. N. Nissen, 43, Mark-lane—Preparing paper for receiving stains or copies from letters and other writings.

1468. H. Greaves, Westminster—Apparatus for moulding, casting, and coating metal articles.

Dated 30th June, 1858.

1470. W. S. Wheatcroft and J. N. Smith, Manchester—Locks, fastenings, or safeguards, making them self-acting or partially self-acting.

1474. J. Petrie, jun., Rochdale—Apparatus for drying warps of yarn or thread, and woven fabrics.

Dated 1st July, 1858.

1476. T. Whiteley, Stainland, Halifax—Manufacture of millboard.

1478. Lieut. J. Kingsley, 52, Great Coram-st., Middlesex—Mechanical arrangements applicable to preventing the sudden bursting of steam boilers.

1480. T. Riddell, Carracon-terrace, Old Ford, Bow—Construction of omnibuses, and in breaks to be applied to wheel carriages.

Dated 2nd July, 1858.

1482. T. W. Smith, 21, Lincoln's-inn-fields—Apparatus for winnowing, washing, sifting, and separating grain, ballast, sand, shot, minerals, and other materials.

1484. J. Morris, Broughton Copper Works, Salford—Construction of copper rollers or cylinders for printing fabrics.

1486. E. Lord, Todmorden, Yorkshire—Looms for weaving, and machinery for making the crank shafts of looms and other machines.

1488. A. V. Newton, 66 Chancery-lane—Lamps.

1490. T. Mellodew, J. Duxbury, and E. Layfield, Oldham—Apparatus for spinning and doubling or twining cotton and other fibrous materials.

1492. D. Le Souef, Twickenham—Shaft-bearer, or tug.

Dated 3rd July, 1858.

1494. J. Billing, Abingdon-st., Westminster—Fire-places or stoves.

1496. C. Buhring, Great College-st., Camden-town—Apparatus for filtering liquids and other fluids containing impurities.

1498. W. Bond and T. Standing, Preston—Apparatus for churning, mixing, and stirring cream, milk, and other liquids.

1500. J. G. Jennings, Holland-st., Blackfriars, and J. Lovegrove, Victoria-park-road — Water-closets, and apparatus used in ventilating house drains or sewers.

Dated 5th July, 1858.

1506. E. Simons, Birmingham—Castors for furniture.

1508. G. J. Newbery, Straitsmouth, Greenwich—Production of coverings for floors, applicable also to the manufacture of table mats, and other articles or coverings.

1510. T. Woolner, Blue Pits, Lancashire—Apparatus for feeding steam boilers with water.

1512. J. Greenwood, South Audley-st.—Marine propellers.

Dated 6th July, 1858.

1513. J. T. Davies, Liverpool—Locks.

1514. J. Dodd and T. Phillips, Ruabon, Denbighshire—Slide valves of steam engines.

1515. H. Hughes, Homerton—Gauffering and crimping machines.

1516. W. E. Newton, 66, Chancery-lane—Roller blinds.

1517. J. Davis and T. Evans, Ulverston, Lancashire—Engines to be actuated by steam, air, or gases.

1518. J. Buchanan, Port Glasgow, Renfrew, N.B.—Propelling ships, vessels, and boats.

Dated 7th July, 1858.

1519. W. A. Smith, Belper, Derbyshire — Machines for making bricks, tiles, or pipes of clay.

1520. H. C. Schiller, London — Apparatus for laying down and recovering submarine telegraphic cables.

1521. J. J. Florance, Paris—Reels or spooling wheels.

1522. P. Mercier, Paris—Treatment of peat, and in preparing the same for fuel.

1523. J. Holland, Gibb-st., Deritend, and F. Potts, Deritend, Birmingham—Ornameuting metallic bedsteads.

1524. W. Clissold, Dudbridge, Gloucestershire—Machinery for cutting or rasping dyewoods.

1525. T. James, St. George's-in-the East—Treating sewage matter.

1526. G. A. B. Chick, 56, Milk-st., Leek-lane—Preparation of graphite, or plumbago, or black lead.

1527. G. T. Bousfield, Loughborough-park, Brixton—Apparatus for ironing linen and other fabrics.

1528. J. D. Weston, Stour Valley Iron Works, West Bromwich—Rolling iron for the manufacture of bolts and pins.

1529. A. W. Sleigh, Mansell-villas, Wimbledon-park—Construction of floating sea barriers, or artificial beaches, breakwaters, and batteries.

Dated 8th July, 1858.

1530. J. F. Stanford, Howard-st.—Apparatus for applying heated air in drying corn, hay, and other like articles, in the stack or otherwise, and in drying goods, and in heating and drying rooms and buildings.

1531. J. Marland, Glodwick, near Oldham, and J. Widdsll, Abbey-hill, Lancashire—Self-acting hook or holder to prevent accidents in lifting, hoisting, or winding at coal pits.

1532. H. Gidlow, Atherton, Lancashire—Breaks for steam engines.

1533. J. B. Booth, Preston, and R. Ashworth, Heywood, Lancashire—Stopping or retarding the progress or velocity of railway carriages.

1534. P. F. Demoulin and J. Cotelle, Paris—Treating the heavy oils obtained from the distillation of coals, schists, and other hydro-carbons.

1535. T. T. Chellingworth, West Bromwich — High-pressure steam-engines.

1536. P. R. Hodge, 16, Chalcot-crescent, Primrose-hill—Brewing fermented liquors.

1537. R. Smith, Sheffield—Adjustable pipe tongs.

1538. S. Samuels, New York—Laying submarine telegraphic cables.

1539. S. Harrison, Stanhope-st., Clare-market—Ovens.

1540. P. J. Crickmer, Borough-road—Treating the sewage of London and neighbourhood.

1541. R. G. C. Fane, Upper Brook-st.—Treating sewage, and in apparatuses to be employed therein.

1542. M. Scott, 3, Stanhope-st., Hyde-park-gardens—Constructing breakwaters, and other like structures.

1543. G. Collier, Halifax—Apparatus for the drying of wool and other fibres.

1544. G. Sampson, Bradford—Apparatus employed in the finishing of woven fabrics.

Dated 9th July, 1858.

1545. W. Simons, Glasgow—Ships or vessels.

1546. G. Parsons, 50, High-st., Lambeth—Apparatus for the prevention of injury to and the sudden bursting of steam-boilers.

1547. J. Broadley, Saltaire, near Bradford—Apparatus employed in weaving.

1548. F. Sang, 42, Charing-cross, and T. W. Rammell, 16, Spring-gardens—Means of conveying letters and parcels.

1549. C. N. Kottula, Liverpool—Manufacture of manure.

1550. F. H. Edwards, Gateshead-on-Tyne Iron Works—Pneumatic springs for railway carriages and other purposes.

1551. J. M. Rowan, Glasgow—Manufacturing wrought-iron wheels and bosses or centres, and in the mode of, and furnaces for, heating the same during such manufacture.

1552. W. E. Newton, 66, Chancery-la. — Umbrellas and parasols.

Dated 10th July, 1858.

1553. A. Porecky, 7, York-st. north, Hackney-rd. — Manufacture of certain articles of whalebone, horn, tortoiseshell, and other corneous matters.

1554. G. H. Wain, Liverpool—Reefing and furling sails.

1555. W. Langshaw, Bolton, Lancashire—Apparatus for weaving fancy-looped or knotted fabrics.

1556. J. F. Watson, 3, Lonsdale-villas, Bayswater, and V. B. Fadeuilhe, Newington-cres. — Preparation of cocoa and chocolate, and also of nutritive compounds from the seeds of the plant called Soja Hispida and Cicer Arietinum.

1557. P. Burrell, 2, Middle Scotland-yard—Ventilating sewers and other receptacles of sewage.

Dated 12th July, 1858.

1559. J. Loach, Birmingham—Ornamenting glass with perforated metallic and other plates.

1560. J. Macintosh, Aberdeen—Apparatus for the manufacture of articles of confectionery.

1563. R. A. Brooman, 166, Fleet-st.—Improved machinery for the manufacture of wire heddles.

1564. D. S. Wilton, 30, Tibberton-sq., Lower-rd., Islington—Pianofortes.

1565. N. Defries, 5, Fitzroy-sq.—Apparatus for measuring gas.

1566. J. Taylor, Roupell-park, Streatham-hill—Manufacture of blocks for the construction of sewers, drains, and arches.

1567. T. Earnshaw, Cambridge-terrace, Thornton-heath, Croydon—Night lights.

Dated 13th July, 1858.

1568. E. Chard, Islington—Pianofortes.

1569. J. Webster, Birmingham — Manufacture of certain kinds of metallic ingots.

1570. J. A. Fussell, Birmingham—Method of ornamenting chandeliers, pendants, and brackets, for gas and other lamps.

1571. J. Travis, T. Sugden, and F. Sugden, Oldham—Lubricating the valves and pistons of steam engines.

1572. J. Edwards, 77, Aldermanbury, London, and T. Newey, 70, Navigation-st., Birmingham — Manufacture of blind furniture.

1573. J. J. Field, Paddington — Supporting and carrying telegraph wires, ropes, and cables.

1574. G. Buchanan, 29, Bucklersbury—Sugar cane mills.

1575. A. Shanks, 6, Robert-st., Adelphi—Machinery for planing, slotting, and shaping metals.

1576. W. Beadon, Otterhead, Honiton—Manufacture of bags for corn and other articles, and sails for ships.

1577. R. Wilson, 9, and A. Horwood, 8, Salisbury-mews, Great Quebec-st., Marylebone-rd.—Pipe joint.

Dated 14th July, 1858.

1579. C. De Poorter, Brussels—Hand or power looms.

1580. W. Woodcock, 36, Great George-st., Westminster—Apparatus for warming air.

1581. R. Burns and J. Rea, Liverpool—Machinery for grinding bones and other hard substances.

1582. J. Cowan, Liverpool—Screw nail.

1583. F. Chapusot, Turin, and V. Avril, Paris—Producing a more or less perfect vacuum, and in applying th same to industrial purposes.

1584. J. Jones, City Waterworks, Oxford—Meters for measuring liquids.

1585. E. Owen, Blackheath—Distilling.

1586. T. Wheeler, Albion Iron Works, Oxford—Combination of machinery for cutting, slicing, grating, and pulping turnips, mangold wurzel, and other roots.

1587. J. Maclean, Edinburgh—Apparatus for laying or submerging telegraph cables in water.

1588. T. Wheeler, Albion Iron Works, Oxford—Washing, wringing, and mangling machines.

1589. H. W. Wimshurst, Wilmot-road, Dalston — Stove grates.

1590. J. Rheinauer, Offenburgh, Baden—Bearings for axles and shafts to lubricate and exclude dust from such bearings.

1591. J. Fowler, jun., 28, Cornhill—Ploughing, tilling, or cultivating land by steam power.

Dated 15th July, 1858.

1592. C. W. Williams, Liverpool—Locomotive and other boilers.

1593. R. Brazier, Wolverhampton—Repeating fire-arms.

1595. C. P. Aston, Cross-st.—Breech-loading arms.

1596. W. A. Gilbee, 4, South-st., Finsbury—Mode of covering cotton, woollen and other thread with silk.

1597. H. Bevan, Shrewsbury—Machine for effecting or facilitating arithmetical operations.

1598. A. H. J. Bastable, Belgrave Works, Ranelagh, Pimlico—Apparatus employed in the production of light.

1599. T. Bartlett, King's-rd., Bedford-row — Stoves, fireplaces, and furnaces.

1600. P. Fairbairn, Leeds—Lathes.

1601. W. E. Newton, 66, Chancery-lane—Mode of giving alarm in cases of fire in houses, ships, or other buildings.

1602. W. Betts, Wharf-rd., City-rd.—Manufacture of capsules.

Dated 16th July, 1858.

1603. T. Leigh, Manchester—Apparatus for sizing warps.
1604. F. Priestley, 15, Berners-st. — Condensing steam engines.
1605. C. de Bergue, 9, Dowgate-hill — Electric telegraph cables for submarine purposes, and machinery for manufacturing such cables.
1606. M. Voss, 12, Billiter-sq.—Safely submerging ocean telegraph cables and other heavy bodies in rivers, lakes, and seas, by means of inflated buoys and connecting gear.
1607. P. Arkell, North Woolwich, and A. Melhado, Queen's-gardens, Bayswater — Submerging of telegraph cables.
1608. A. P. Price, Margate—Treatment and smelting of certain ores or compounds of tin, and of tin and of certain alloys thereof.
1609. C. S. Putnam, New York—Apparatus for hardening vegetable gums, oils, and other substances susceptible of being hardened by steam.
1610. T. F. Chorley, 9, Cottage-pl., City-rd.—Improving the form of bankers' cheques, and other similar documents, with the view of preventing fraudulent dealings therewith.
1611. W. A. B. Bennett, 13, Rue Tant perd tant prie, Boulogne —Military capes or cloaks.

Dated 17th July, 1858.

1612. T. Hart, Glasgow—Taps or valves, and apparatus for regulating the flow of fluids.
1613. J. Spence, Liverpool—Manufacture of tin plates and terne or leaded plates.
1614. J. T. Smith, Dudley, Worcestershire — Improved manufacture of coke.
1615. W. Wildes, Maidstone — Arrangements of machinery for reducing vegetable matter to pulp.
1616. R. A. Brooman, 166, Fleet-street — Apparatuses for the reception of fecal and sewage matters.
1617. W. Pidding, Southwark Bridge-road, Southwark — Securing and forming envelopes.
1618. W. A. Lloyd, Portland-rd., and E. Edwards, Menai cottage, Anglesea — Aquaria tanks and similar receptacles for aquatic animals and plants.

Dated 19th July, 1858.

1619. J. J. Desmares, Vire, France — Process for oiling wools.
1621. C. Bray, 14, Alfred-ter., Queen's-rd., Bayswater—Ice safes.
1622. H. Smith, Brierly-hill Iron Works, near Dudley—Manufacture of harrows.
1623. C. Reeves, Birmingham—Repeating fire-arms.
1624. T. Greenwood, J. Batley, and J. Salt, Leeds—Machinery for preparing silk to be spun.
1625. J. W. Wilson, Duke-st., Adelphi — Preparation of materials to be used for roofs and other parts of buildings, and for various purposes for which wood is now generally employed.
1626. W. Tasker, jun., Waterloo Iron Works, near Andover —Combined thrashing machines.
1627. T. F. Chorley, 9, Cottage-pl., City-rd. — Form of bankers' cheques, and similar documents, with the view of preventing fraudulent dealings therewith.
1628. W. Herapath, Bristol—Treatment of paper with the view to the prevention of forgery.
1629. C. Lambert, Sunk Island, Yorkshire — Collars for horses and other draught animals.
1630. S. Maw, Aldersgate-st. — Feeder for administering food.

Dated 20th July, 1858.

1631. J. Schmitt, Guernsbach, near Radstadt, Baden—Cementing, hardening, and tempering rails for railways, and also axles for railway carriage-wheels.
1632. J. Chadwick, Castleton Print-works, near Rochdale—Application of certain woven fabrics to printing purposes.
1633. J. Shand, Blackfriars-rd.—Fire-engines and pumps.
1634. T. Bailey, New Orleans, U.S.—Repeating fire-arms.
1635. J. C. Hill, Kentish-town — Making joints for connecting pipes and other articles by means of lead or other soft metal.
1637. C. Doley, Birmingham, and E. Bigland and H. Worrall, Smethwick—Ornamenting metallic and non-metallic surfaces.
1638. G. Wheatley, Bethnal-grn.-rd. — Ornamenting of sticks.
1639. R. A. Brooman, 166, Fleet-st.—Moveable apparatuses for receiving fecal and sewage matters.
1640. W. N. Nicholson, Newark-on-Trent—Crushing mills.

Dated 21st July, 1858.

1643. E. Hardon, Stockport—Manufacture of woven fabric for covering umbrellas and parasols.
1644. J. W. Wilson, Barnsley—Apparatus for turning and cutting wood and other substances.
1645. M. Matley, Ashton-under-Lyne—Steam boilers for consuming smoke and economising fuel in the generation of steam.
1646. T. Piatti, Paris—Propeller.
1647. L. Cunq, Bordeaux, France—Calculating machines.
1648. H. Allnutt, 77, Fleet-st.—A vehicle for lamplighters.
1649. J. W. Giles, St. Martin's-le-Grand—Locomotive or traction engines.
1650. J. Meacock, Snow-hill—Wet gas meters.

Dated 22nd July, 1858.

1651. D. W. Warder, 4, Caroline-pl., Chelsea—Manufacture of beams, girders, ships' ribs or frames, and other structures of wrought iron.
1652. B. Blake, Eccleston, near Prescot, Lancashire—Kiln for burning earthenware and other similar articles.
1653. H. Green, Liverpool—Hinge for hanging and closi doors, gates, or windows.
1654. C. Gammon, 9, Cloak-la.—Fastening of envelopes and letters.
1655. W. L. Thomas, Union-st., Berkeley-sq. Ordnance, fire-arms, and apparatus generally in which gunpowder is employed.
1656. J. B. P. A. Thierry, jun., Paris—Furnaces.
1657. A. B. Tripler, 1, Michael's-grove, Brompton—Obtaining products from a species of asphaltum at present found in the Island of Cuba, and called Chapafote.
1658. H. Higgins and T. Whitworth, Salford—Machinery for spinning and doubling or twining cotton and other fibrous materials.

Dated 23rd July, 1858.

1659. L. J. Marks, Newport, Monmouthshire—Compasses.
1660. W. A. Gilbee, 4, South-st., Finsbury—Rotary engine.
1661. R. P. Walker, New York, U.S.—Machinery for hulling and finishing rice and similar grains.
1662. H. Barber, Leicester — Machinery for producing knitted fabrics.
1663. G. Bruckelbank, 71, Lombard-st.—Laying submarine cables for telegraphic purposes.
1664. W. Parsons, Pratt-st., Old Lambeth—Separating the solid matter from sewage waters.
1665. H. J. Giffard, Paris—Feed apparatus for steam and other boilers.

Dated 24th July, 1858.

1666. C. Atkinson, Sheffield—Venetian blinds.
1670. S. Townend, Blossom-st.—Cranes.
1671. J. F. Belleville, Paris—Smoke-consuming apparatus or furnace.
1672. H. C. Traphagen, New York—Ladies' skirts.

Dated 26th July, 1858.

1674. D. Adamson, Newton Moor Iron Works, Hyde—Hydraulic apparatus for raising and lowering heavy articles, and in the application of hydraulic power for rivetting metallic structures, as iron ships' boilers, tanks, and similar articles.
1676. C. F. Vasserot, 45, Essex-st., Strand — Glass-roofs, skylights, windows, and other glass structures.
1676. A. Sax, Paris—Wind musical instruments.
1677. J. Cooke, Belfast — Singeing, treating, or finishing textile fabrics.
1678. J. Hardie, Stirling, N.B.—Apparatus for regulating the flow or passage of fluids.
1679. J. Taylor and J. Nimmo, Glasgow — Healds, and machinery or apparatus for making healds.
1680. B. T. S. Harris, Brooklyn, New York—Registers for indicating the presence or absence, and the time of arrival and departure, of workmen or employeés.
1681. C. de Jongh, Cautenbach, France — System of and machinery for heckling or combing flax, silk, or other fibrous substances.
1682. T. Hall, Mildmay-park, Islington — Apparatus for indicating a rise of temperature in confined spaces.
1683. E. Jones, Olive-house, 20, Camden-cottages, Camden-town—A better system of drainage, and the machinery and apparatus necessary for the same, whereby the sewage manure is collected and conveniently exported for use, noxious effluvia prevented from contaminating the air of populous cities and towns, and whereby the drains may be more strongly and securely built, by the manufacture of a more suitable and better material.
1684. H. Jackson, 130, Powis-st., Woolwich — Preparing lubricating matters.
1685. J. Hope, Rhode Island, U.S.—Apparatus for supporting and adjusting a graver of a machine for engraving the surface of a calico printer's roller, preparatory to the same being etched.
1686. J. Davies, Serjeant-Major, Royal Military College, Sandhurst—Cloaks for military and other purposes.
1687. P. A. Godefroy, 3, Kingsmead-cottages, New North-rd., Islington—Cleansing of gutta percha, and in the more perfect insulation of electric telegraph wire.
1688. Henry Glover, New York, U.S. — Instruments for measuring angles and taking altitudes.

Dated 27th July, 1858.

1689. H. Ashton, Bewley-st., Kirkdale—Furnaces of steam boilers.
1690. J. Scott, Tain, N.B.—Pumps.
1691. J. Emes, 110, Great Russell-st., Bloomsbury—Folding bedstead.
1692. T. Line, Lower Tower-st., Birmingham—Engines for raising beer and other liquids.
1694. C. N. Kottula, Liverpool—Manufacture of soap.
1695. J. Long, Little Tower-st. — Cooling brewers' and distillers' worts and other liquids.

Dated 28th July, 1858.

1698. A. Pougault, Decize (Nievre), France—Apparatus for purging or clearing steam engines of their condensed water.
1700. R. Howarth, Slater Field Foundry, Bolton-le-Moors, Lancashire—Furnaces for steam boilers for the purpose of consuming smoke and economising fuel.
1702. W. A. Gilbee, 4, South-st., Finsbury—Preparation of hydrated oxide of chromium.
1704. J. Taylor, J. Lang, and J. Uttley, Castle Iron Works, Stalybridge, Chester—Self-acting mules for spinning and doubling.
1706. J. Miles, Risca, Monmouthshire — Annealing pots used in the manufacture of iron, steel, and other metals.
1708. W. Buckingham, Broad-st., Bloomsbury, C. Humfrey, Camberwell, and L. R. Sykes, Duke-st., Manchester-square—Telegraphic cables.

Dated 29th July, 1858.

1710. G. Cavaggia and A. Spinelli, Avignon, France—Applying motive power.
1714. J. Brierley, Kirkheaton, Yorkshire—Apparatus for spinning wool and other fibres.

Dated 30th July, 1858.

1716. J. F. W. Featherstonhaugh, Surrey-sq., Newington, and F. Wise, Peckham-grove, Camberwell—Self-acting apparatus for admitting water to steam-boilers, and indicating the water level.
1718. J. Luis, 18, Welbeck-st., Cavendish-sq.—An apparatus for cooling beer and other liquids.
1720. G. W. Reynolds, Birmingham—Improved cradle.
1722. J. Watkins, Newport, Monmouthshire — Apparatus for the manufacture of tallow and other candles.
1724. H. Bessemer, 4, Queen-st.-pl., New Cannon-st.—Treatment of pit-coal, and in the separation of foreign matters therefrom.
1726. J. Davey, H. Sims, J. Mayne, W. Hodge, and J. Gerrans, Gwennap, Cornwall — Construction of valve applicable to various descriptions of engines or machinery.
1728. N. S. Dodge, 44, St. Paul's-churchyard — Treating waste vulcanised india rubber.

Dated 31st July, 1858.

1730. General H. Douglas, Bart., Green-st., Grosvenor-sq.—Freeing screw propellers from wreck or gear with which they may become entangled.
1732. W. C. S. Percy, Manchester—Manufacture of bricks, tiles, pipes, and other articles made of plastic earths.
1734. G. Davies, 1, Serle-st., Lincoln's-inn—Apparatus for planing electrotype and stereotype plates.
1736. H. Conybeare, Abingdon-st., Westminster—Machinery for the laying of submarine telegraph cables.
1738. G. T. Bousfield, Loughborough-pk., Brixton—Knitting machines.

Dated 2nd August, 1858.

1742. W. H. Crispin, Marsh Gate Lane, Stratford—Construction of electric telegraph cables.
1744. J. W. Schlesinger, Red Grove House, South Lambeth —Machine for roasting and basting articles of food.
1746. G. Davies, 1, Serle-st., Lincoln's-inn—Manufacture of bituminous mastics.
1748. C. Mortimer, South Carolina, U.S.—Apparatus for raising and lowering ships' boats.
1750. J. L. Norton, Belle Sauvage-yard, Ludgate-hill—Apparatus for drying wool and other substances.
1752. H. Greaves, Westminster—Constructing streets, roads, and ways, thereby facilitating traffic and providing for the more convenient conveyance of sewage, drainage, gas and water supplies, and telegraphic wires along the same.

Dated 3rd August, 1858.

1754. W. Taylor, Titley-cottage, Kington, Hertfordshire—Manufacture of iron.
1756. T. Greenhalgh, Bury, Lancashire—Apparatus applicable to steam boilers.
1758. R. Cunningham, Paisley — Production of letterpress printing surfaces and surfaces used in reproducing ornamenting patterns or devices by printing or otherwise, and in the apparatus connected therewith.
1760. G. Bell, Fore-st.—Embossing and printing dies, and in the manufacture of "lace" or perforated embossed paper.
1762. J. H. Johnson, 47, Lincoln's-inn-fields—Inkstands.
1764. A. V. Newton, 66, Chancery-lane — Machinery for forging nails and other articles.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

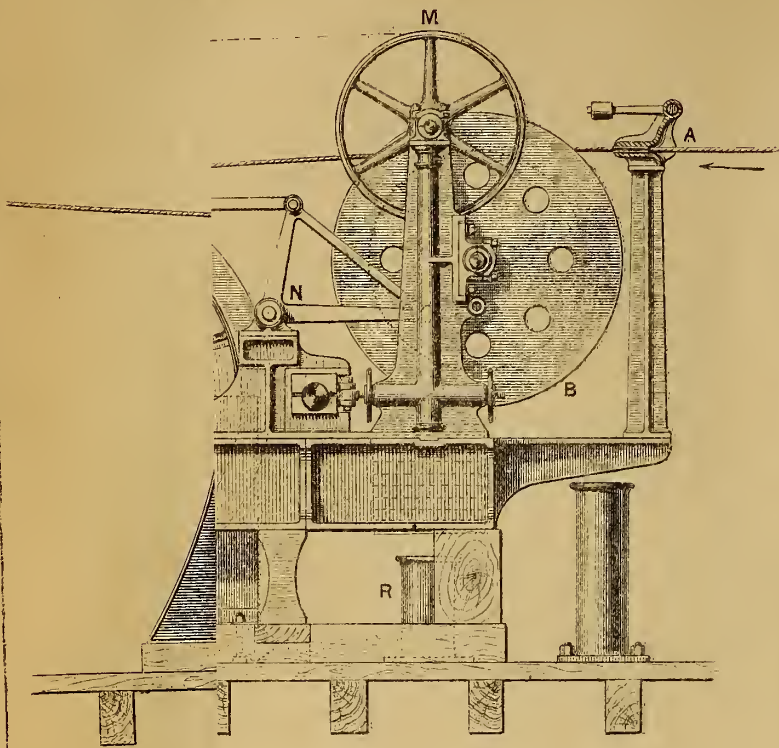
1562. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Construction of fire-engines and similar apparatus. —12th July, 1858.
1641. J. V. N. S. Petrziwalsky, Pall-mall—Manufacture of bread.—20th July, 1858.
1667. M. Shanty, 5, Meard's-st., Dean-st., Soho-sq.—A mercurial level, to show the height of liquids in enclosed and opaque vessels, vases, and principally for steam boilers.—24th July, 1858.
1669. M. Shanty, 5, Meard's-st., Dean-st., Soho-sq.—A metallic trimming for intercepting water, air, gas, or steam round piston rods, of whatsoever they may be; the same may be applied to the joints of steam machines.—24th July, 1858.
1696. G. Hurn, Norwich—Manufacture of certain articles made from fibrous materials.—28th July, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4107. July 17. M. Schelham, Birmingham, "Penholder."
4108. „ 22. C. H. Hall, Grosvenor-st., London, "Apparatus for containing and supplying Blacking and other fluids."
4109. Aug. 2. Bathgate and Wilson, Canning Foundry, Liverpool, "A Ship Ventilator."
4110. „ 4. B. Goodfellow, Hyde, Chester, "Boiler Flue."
4111. „ 7. W. H. Atkinson, Tynemouth, "Improved Wet Gas Meter."
4112. „ 18. A. J. Clarke, Wolverhampton, "Safety Cab and Carriage Lamp."
4112. „ 18. W. Gillett, Market-place, Hull, "The Atmospheric Hat."

IC TELEGRAPH CABLE

MNON"



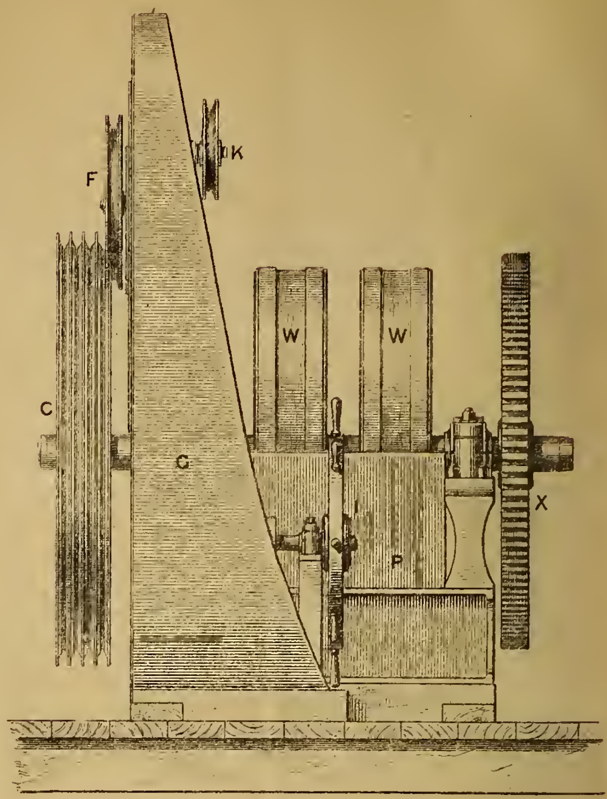
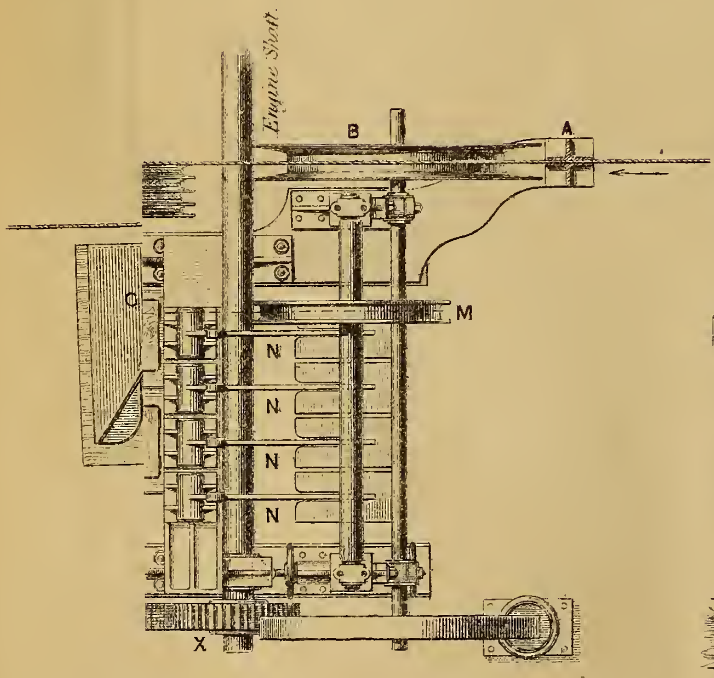


FIG. 3. END ELEVATION.



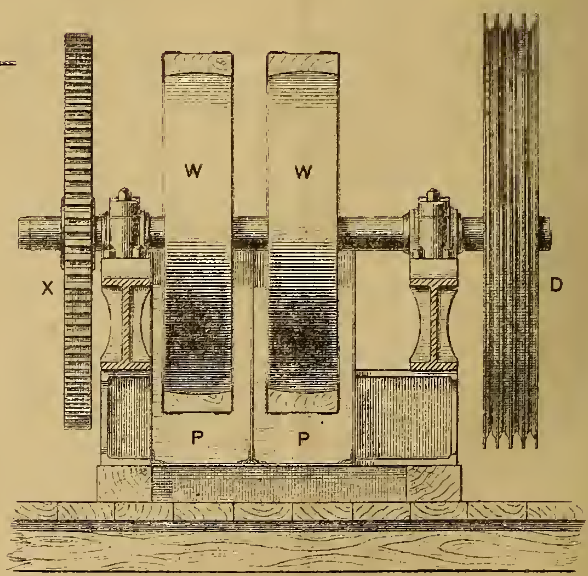


FIG 4 CROSS S'CTION.

14 16 FEET.

PAYING-OUT MACHINERY OF THE ATLANTIC TELEGRAPH CABLE

AS ON BOARD H.M.S. "AGAMEMNON"

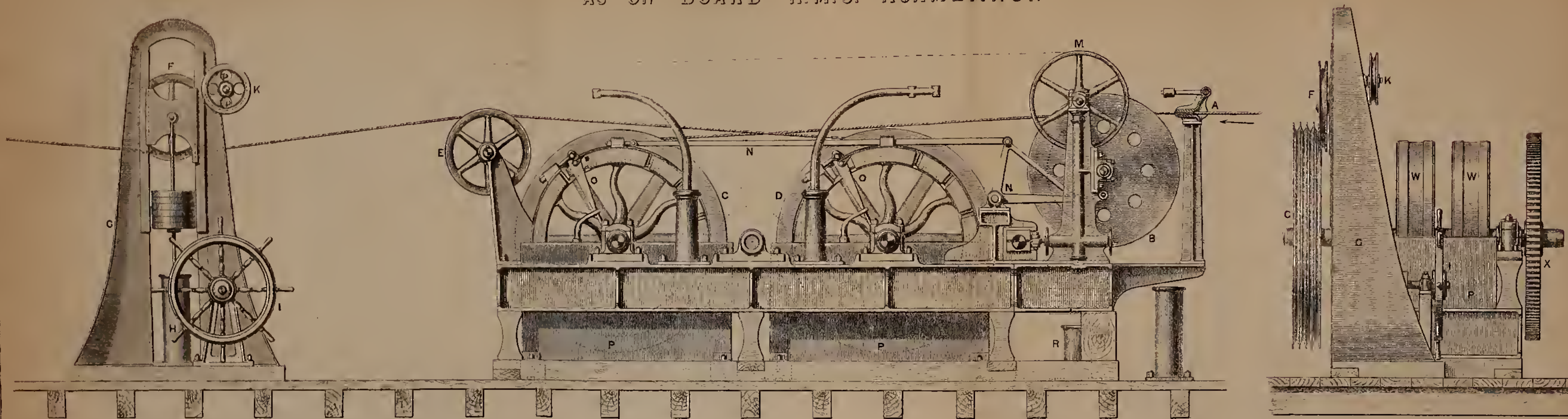


FIG. 5. FIG. 1. SIDE ELEVATION FIG. 3. END ELEVATION.

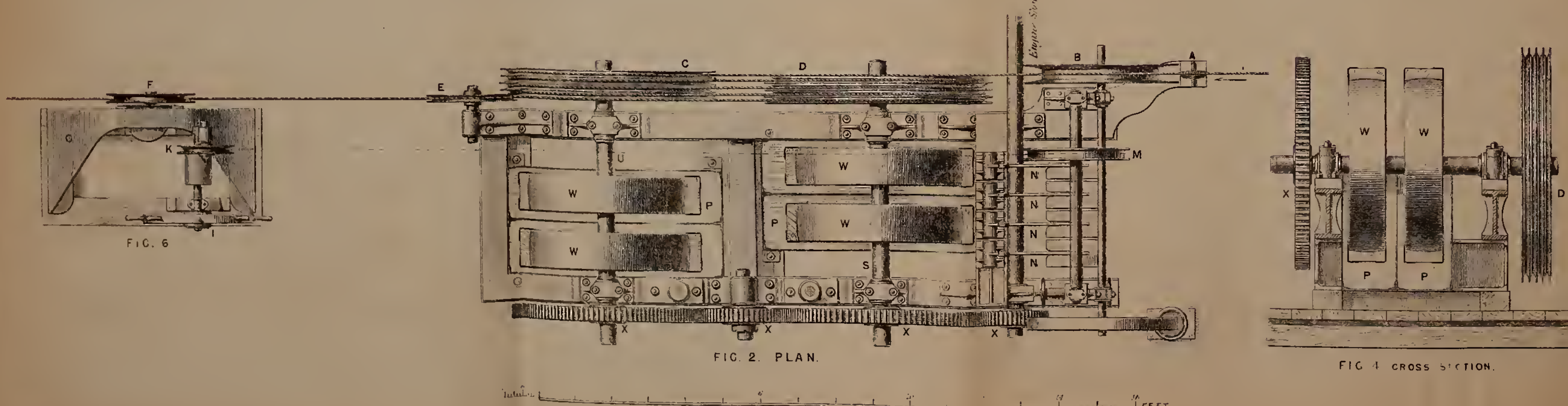


FIG. 6 FIG. 2. PLAN. FIG. 4. CROSS SECTION.

Fig. 6.

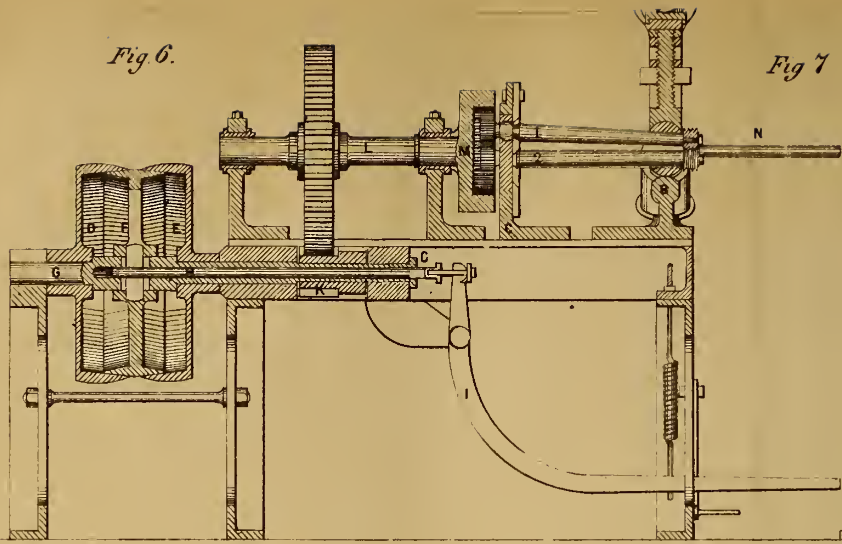
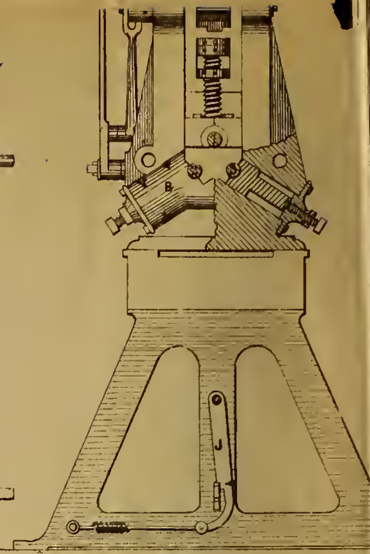


Fig 7



Scale for Figs. 6 & 7
Ins 12 6 0 1 2 3 4 5

THOMSON'S CENTRIFUGAL PUMP.

Fig. 10.

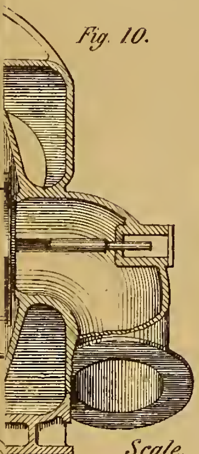
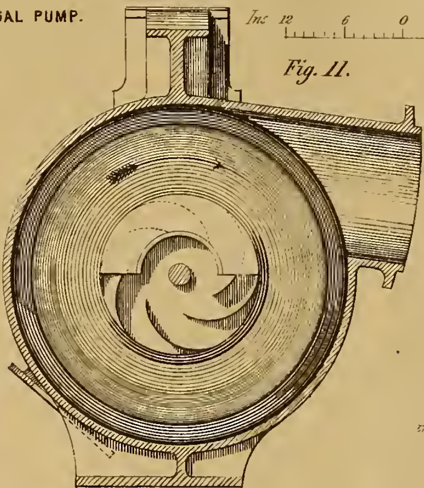


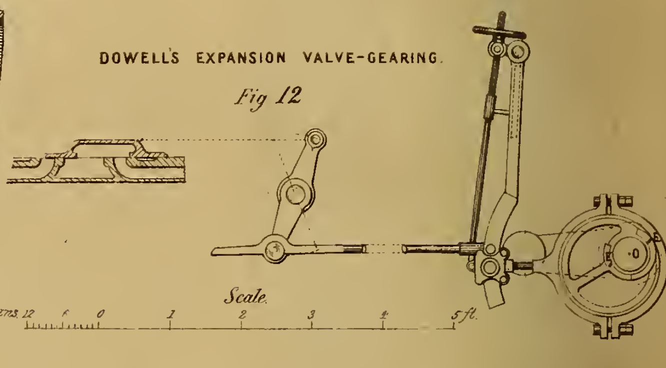
Fig. 11.



Scale.
1 2 3 4 5 Ft

DOWELL'S EXPANSION VALVE-GEARING.

Fig 12



Scale.
Ins 12 6 0 1 2 3 4 5 ft.

ROBERTSON'S WINCH.

Fig. 13.

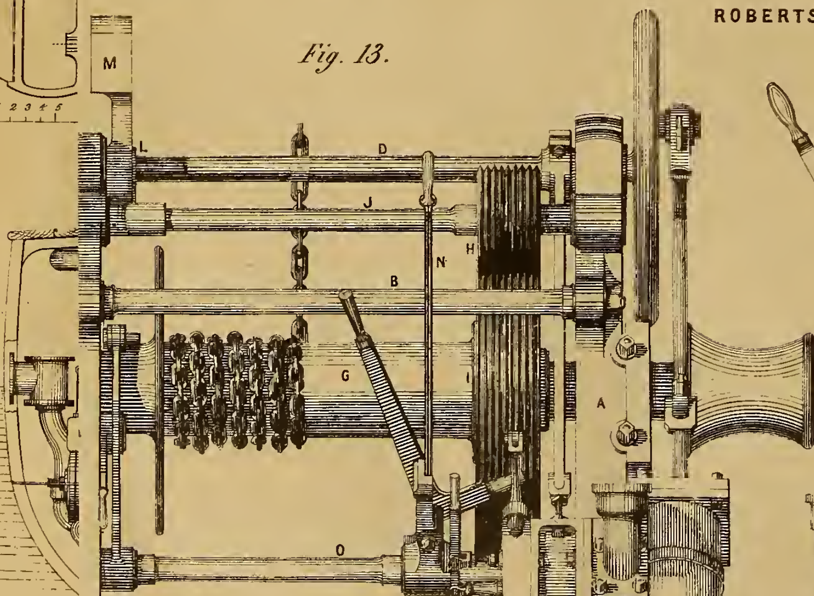
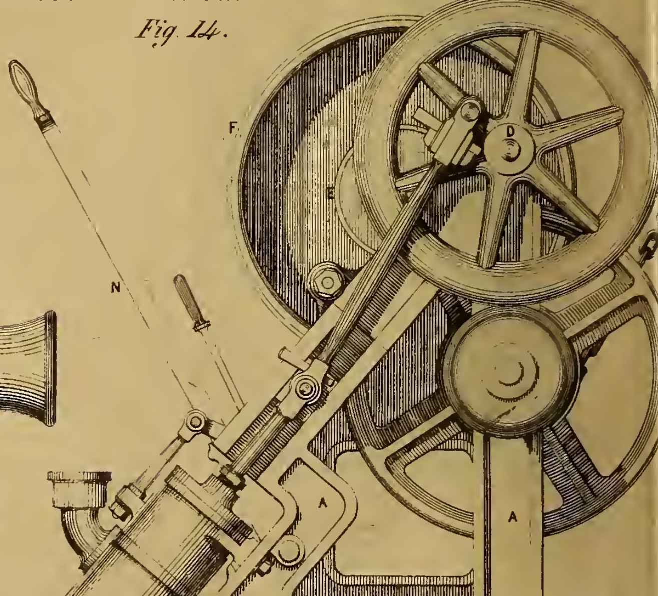


Fig. 14.



Scale.
Ins 12 6 0 1 2 3 4 5 Ft.

W. Smith,

THE ARTIZAN.

No. CLXXXIX.—Vol. XVI.—OCTOBER 1st, 1858.

THE ATLANTIC TELEGRAPH PAYING-OUT MACHINERY.

(Illustrated by Plate No. cxxxi.)

The paying-out of the Atlantic telegraph cable having been successfully performed—though, unfortunately, since the success was achieved an imperfection in the insulation has occurred, an interruption in the receipt and transmission of intelligible signals between Europe and America—we now present to our subscribers the accompanying copperplate engraving of the machinery employed in hauling up the cable from the holds and other places in which the cable was stowed on board H.M. steam frigate *Agamemnon*.

The machinery first employed on board the *Niagara* and the *Agamemnon* was designed and patented by Messrs. Bright and De Berguc; but after the attempts which were made last year to lay down the cable had proved unsuccessful, those machines, after being proved defective, were removed, and a committee of scientific men having been formed, it was determined to adopt a modification of the first arraugement, and superadd an arrangement of breaks designed by Mr. Appold, F.R.S., by which the amount of strain and action could be perfectly regulated and adjusted.

A paper upon the subject of the construction and means employed to pay out the cable has for some time past been completed, but which, in deference to the wish of some of the parties professionally interested in the subject, we have determined to withhold the publication of for a short time; we therefore, at the present time, only give the plate illustrating the paying-out machinery, and proceed briefly to describe the several parts of the machinery.

The several figures in the accompanying plate represent a side elevation of the paying-out machine and the dynamometer apparatus, and a plan of the same, as also two end views of the machines—the one showing the taking-in end, the other the paying-out end of the apparatus; the letters of reference employed are the same in each view, and refer to corresponding parts.

We will describe the course of the cable through the machines as it passes up from the coil, which is in course of being unwound. The cable enters the hauling-up and paying-out machine by a guide-way or slot, A, which directs it on to a grooved wheel, B, which in turn directs it into the outer groove of the further four-grooved drum, D, around one side of which it passes, and returns horizontally to the under side of the drum, C, around the first groove of which it passes, and leaving the top side of the drum, C, the cable is made to pass horizontally to the top side of the drum, D, in the second groove of which it passes round to the under side, and thence to the second groove of the drum, C, and so on, until after passing four times round the drums, it leaves the top side of the drum, C, and after passing over a bearing-pulley, E, it leaves this machine to pass under a grooved wheel, F, which is mounted on a stud fixed upon a sliding block, which travels up and down in the frame or standard, G. The weight of this sliding block and pulley is balanced by counter weights, which are slid into a rod, the lower end of which has a small and very loosely fitting piston attached to it, working in a cylinder, H, partially filled with water; the use of this part of the apparatus being to check any sudden jerk or strain. The cable, after passing under the pulley, F, passes over the grooved drum or sheave mounted on the end of an outrigger frame projecting over the stern of the ship.

A steering or hand wheel, I, is mounted on a shaft, which works in bearings in one side of the frame or standard, G. The shaft of this hand-wheel, I, has a drum upon it, from and around which a chain passes up to a directing pulley, K, and horizontally to another pulley, M, to which it is attached; this pulley is mounted on a shaft; the four brake levers, N, belong to the four friction-drums, W. The four friction-drums, W, are mounted upon two shafts, S and U, which also have fixed upon their outer or overhanging ends, on one end of each, the four-grooved drums, C and D, whilst at the opposite end of each a spur-wheel, X, is fixed. These wheels, X, have between them, and geared into them, the pinion, X; the spur-wheel of the first drum, C, being driven by a pinion, X, which is fixed upon the motion shaft from the driving engine.

The four friction-drums, W, work in troughs, P, containing water. The wooden brake blocks are mounted on the inner surface of the iron brake straps, which are constructed upon Mr. Appold's principle, and are regulated by the arrangement or mode of connecting them at O.

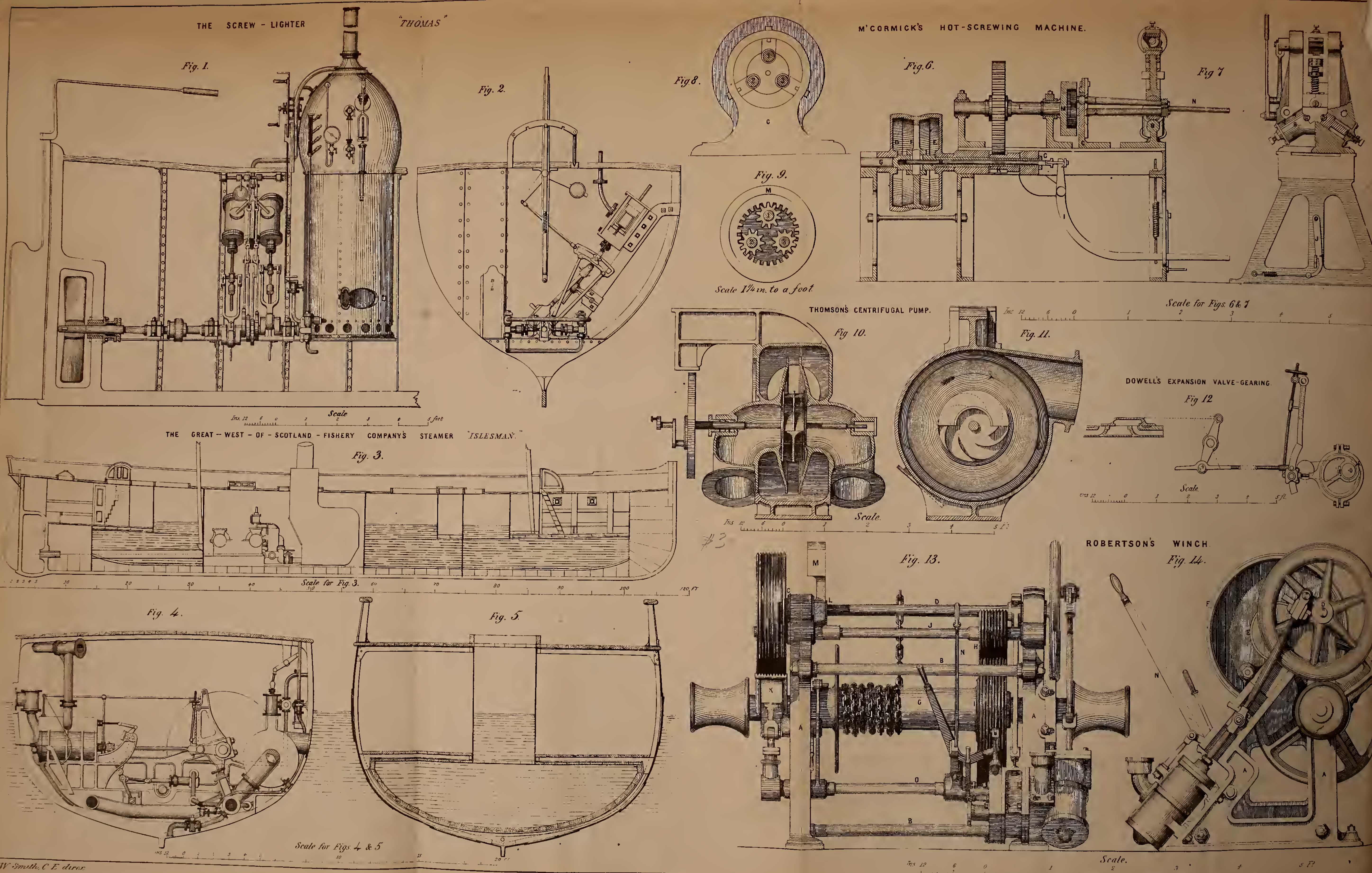
The maximum amount of friction being first regulated by the number of movable weights attached to each brake, the hand-wheel is made to act in reduction of the amount of resistance offered to the passage of the cable through the machine; whilst outer cylinders are fixed under the weight-rods of the brake levers to prevent any very sudden jerk or strain.

We propose in our next to illustrate separately, and on a larger scale, the Appold brake apparatus, and to resume the present subject.

THE COAL QUESTION AND THE PROSPERITY OF GREAT BRITAIN.

If anything in this world may be regarded as a political axiom, then we assert that the vital sympathy which exists betwixt the prosperity of Great Britain and the production and utilisation of fuel, is precisely that union of circumstances and consequences which enables us, in a few words, to illustrate a vast mass of deductions, or, in other terms, to utter an undeniable axiom. In addressing a nation which claims, "*par excellence*," the title of being "the world's manufacturer," it may perhaps seem superfluous to point out the vast importance of the principles contained in the above axiom; yet, unhappily, it is no less our duty at the same moment to tell this very nation that its Government at least has most shamefully neglected the entire subject to which those principles are applicable. We will not stay here to dwell upon that notoriously defective collection of absurdities which, under the name of "Admiralty Coal Report," serves but to disgrace our national character for practical accuracy: it is enough that, at the eleventh hour, we now learn from the confession of one whose evidence is not to be disputed on this point, that the experiments upon which this Admiralty Report is founded were made with "an unfit boiler;" and when to this we add, that the said experiments were moreover conducted under the influence of a fallacious theorem, to the effect that the "calorific value of a fuel is proportioned to the amount of coke or fixed carbon which it will yield," we believe that we have said enough to vindicate the character above assigned to this report, without in any way risking our acknowledged title for critical moderation.

We might, indeed, here not improperly pause, and express our regret that the fallacies thus foisted upon the world by the ignorance of governmental officials, should have produced injurious consequences, extending beyond the mistaken selection of one kind of coal to the exclusion of another equally valuable: we might even solicit attention to the mischief already caused, and to be caused, by the investment of capital in the development of certain mining districts, which now find themselves overwhelmed by an unnatural and injudicious production, at a time when the hitherto misrepresented and excluded coal is beginning to react and create a serious competition through the mere diffusion of truth and knowledge, and by which an evil is originated that increases every day, and threatens a considerable part of our Welsh coal field with calamity, simply because a worthless report had indicated that successful competition from any other quarter was a virtual impossibility. But questions of this kind, though individually or locally of importance, sink into insignificance before the great national axiom to which we propose to elevate our present remarks. The real question for Great


THE SCREW - LIGHTER "THOMAS"
Fig. 1.
Fig. 2.
Scale
THE GREAT - WEST - OF - SCOTLAND - FISHERY COMPANY'S STEAMER "ISLESMAN."
Fig. 3.
Scale for Fig. 3.
Fig. 4.
Fig. 5.
Scale for Figs. 4 & 5
W. Smith, C.E. direx
Fig 8.
Fig. 9.
Scale 1¼ in. to a foot
M'CORMICK'S HOT-SCREWING MACHINE.
Fig. 6.
Fig 7
Scale for Figs. 6 & 7
THOMSON'S CENTRIFUGAL PUMP.
Fig 10.
Fig. 11.
Scale.
DOWELL'S EXPANSION VALVE-GEARING
Fig 12
Scale
ROBERTSON'S WINCH
Fig. 13.
Fig. 14.
Scale.

Britain is, How or in what way can we render our mineral fuel more valuable or useful than at present? Much have we heard of that wonderful aphorism which commends the merit of the man who can "make two blades of grass grow where one only previously grew;" and without seeking to controvert the wisdom of this teaching, let us point to the value of that man's merit who can make one ton of coals do the work of two. Taken on an average, we raise yearly in this country 60 millions of tons of coals, which, at the place of consumption, may not unreasonably be valued at ten shillings per ton, or, in other words, at a total value of 30 millions sterling; but the man who can elicit from this coal twice the work now obtained, has really in this ratio added to our national wealth. And is there no hope that this result may be reached? Is there no prospect that such an end may be arrived at? Let us examine the matter a little more closely.

For many years it has been customary to regard the evaporative power of Newcastle coal as equal to the conversion of six or seven times its weight of water into steam: such were the data of Watt and many others, and if we look into the more recent Admiralty report we shall find that a very similar result has been there arrived at. In this last instance, indeed, we know that after ten years' silence, it has slipped out that an "unfit boiler" is to be blamed for this obvious deficiency, which contrasts rather unpleasantly with the results of more careful experimenters, and from which we learn that twelve times the weight of the coal, or nearly double the weight of the above evaporative power, can be obtained by what, after all, we must be permitted to call only "*a less unfit boiler*," as no person pretends that perfection has yet been attained. Here, then, is a subject surely worthy of the careful attention of Government, and quite within its grasp—What is the best shape and form at present known with regard to boilers, for developing the evaporative powers of the various kinds of coal applicable to steam purposes, and especially to the requirements of ocean transit? If we knew the best form of boiler for each of the varieties of coal that now are presented in the market, much might no doubt be done in the way of improvement; but no such guide is at hand. and it is scarcely saying too much to assert, that nothing whatever is known of the principles which favour the practical transmission of heat from the furnace of a steam boiler, to the water which is to generate a power proportioned to that transmission.

Nothing is more certain than the fact that when coal is completely burnt, it invariably produces a fixed amount of heat; but can anyone tell how much of this amount is absorbed and utilized in the various kinds of boilers now employed? We assert fearlessly, that with the great majority of such boilers, more than one-half the heat produced is lost or wasted: one-half of the fuel is thrown away through carelessness or ignorance. Is this, then, not a national question, or a subject more worthy of Ministerial consideration than nine-tenths of the puny problems which serve only to fritter away that intellectual *hiatus* called "a parliamentary session"? The importance of ascertaining the evaporative value of coal has been conceded, but how can this be done until we know what form of boiler to use in experimenting upon each variety of coal? Are we again to repeat the Admiralty farce with "an unfit boiler?" or shall we not, like rational beings, desire the Government to furnish us with tools suitable to the required end, ere we seek to arrive at a correct conclusion? This, we repeat, is a strictly Governmental inquiry, and one which ought to be undertaken and replied to, before any attempt is made to determine the real evaporative power of coals. If the Admiralty report proves nothing else, it at all events proves the correctness of the basis we have here taken. It is impossible to do justice or arrive at the truth with respect to the value of coal, until each of the varieties of this mineral has been tried under the conditions best adapted to elicit its calorific power; and it is well known that the conditions best adapted for one kind of coal are utterly unfit for another.

Turn we now to a consideration of the differences that exist amongst the coals raised in different parts of this country—from smokeless anthracite to flaming bituminous coal. What actually is the range of heating power within which the qualities of these varieties are included? This is at present an interesting question, and we have taken some trouble to answer it in a conclusive manner: we have collected genuine specimens of the different coals of this and some other countries, and submitted them to examination. The result proves that, as regards coals of all kinds, the differences in calorific power extend from 12½ to 16, and that the article sometimes mistaken for coal, and properly called "lignite," never possesses a heating power of more than 11. With respect, however, to the two qualities of coal which are chiefly used for sea-going purposes—viz., the semi-bituminous Welsh and the open-burning Hartley—the evaporative power is almost alike, and varies only from 14·3 as a minimum to 14·8 as a maximum. Thus the experiments recently made at the request of the North Coal Association, by two of the *employés* of Government, were conducted upon coals of which we have been furnished with specimens, and which we find to differ only in the proportion of 14·3 and 14·5. The first result was derived from a coal of the Newcastle kind called Bebside, and the last from a Welsh coal called Powel's Duffryn. We have not yet heard whether any report is to be presented to the public in connection with this inquiry, and, in fact, if we are not mistaken, the experiments point to other matters than the mere heating power of the coals employed—such, for instance, as the amount of fuel which could be consumed upon each square foot of furnace grating in the course of a given time. If this be so, then we shall have no better standard than before, in an economical sense, even if this report is published, because the evaporative power will be mixed up with other contingencies that may never again become applicable in practice. No doubt, in the case of war steamers, it is occasionally of vital importance that at any cost a great increase of power and speed can be obtained: such a vessel may wish to pursue or to avoid pursuit, or she may happen to find herself upon a lee-shore during a hurricane, which latter circumstance may occur also to a mercantile steamer. It is therefore clearly of importance that this point should be investigated amongst others, in order that we may know the relative periods in which, by different coals, a given force of steam can be generated, or an extra force produced upon occasion; but, meanwhile, we must begin by clearing our way, and not attempting to do everything at once. Thus, when we have ascertained the best form of furnace and boiler for each coal, we can determine the real evaporative power of the several varieties; and this having been settled, we may then proceed to questions of a special nature, like that to which we have alluded. Nor will it surprise us to learn that the requirements of war steamers indicate the employment of fuel different from that which would be advantageous to our mercantile steamers. In the first place, the question of stowage is quite a secondary consideration with war steamers; indeed, in vessels of this nature, a bulky description of fuel might be the best, provided it possessed the quality of great accendibility, and could suddenly generate an immense amount of heat from a small area of furnace grating. But to a mercantile vessel this same fuel might probably be useless, simply because its bulk would render the conveyance of cargo impossible; thus, no mercantile steamer could be usefully navigated during long voyages by means of wood as fuel, because the bulk of the fuel would then occupy the whole stowage.

We cannot pretend, within the brief space open to our present remarks to do justice to the contingent circumstances which, over and above the heating power of fuel, must influence its value in a commercial aspect; it is enough if we briefly glance at these points, and solicit the attention of a good and paternal Government to their consideration. Take, for example, the cohesive nature of coal, or power of resisting pulverization. This must be examined on two totally different grounds, because, although when first dug a coal may be found to possess a satisfactory degree of cohesive power, it is no evidence that it will retain this power after an exposure to atmospheric influences for a period of three or six months. It is well known that certain coals disintegrate, or fall to powder, spontaneously when exposed to the air, and are consequently unfit for long voyages, or for storage in those parts of the world intended to supply ocean steamers, as at Aden, Ceylon, Malta, &c. This character, then, should be specified as a warning to shippers of coal, and ought therefore to constitute a prominent feature in the Government report.

Another circumstance is this: it appears that some descriptions of coal have the power of absorbing oxygen from the air, in the manner common to resins; this absorption greatly diminishes their heating power, and is in fact a kind of slow combustion, by which the original calorific quality of the coal is dissipated and lost. In this respect coals differ greatly, though, as might be expected, the deterioration is generally proportioned to the extent of surface exposed to the air, or, in other words, to the pulverulent state of the coal. In this particular nothing whatever has been attempted, although it is practically known to engineers of sea-going vessels that the powdered coal, or coal-dust, which has been long kept in store-houses, is not worth the labour of throwing into the furnace; in fact, the usual practice is to cast it overboard. When, however, we come to consider the value of coal after transmission to such places as Aden or Ceylon, it cannot be a trifling matter to know beforehand that with some kinds of coal the whole will be useful, whilst with other kinds one-half will be converted into worthless dust, which must be thrown into the sea.

Another subject is the intermixture of coals from different localities, or from different seams, with a view to improve the quality of the fuel. There is, we feel convinced, much advantage to be gained by a judicious treatment of this matter; but the more we have examined into the merits of a governmental inquiry upon coal, the more we are satisfied that to be beneficial it ought to be permanent. Not only do seams of coal themselves vary in different parts of their workings, but it is no uncommon thing to extract two, or even three, varieties of coal from one and the same shaft or pit. Of course, all these varieties are equally entitled to the name of the pit, and presuming this pit to have established for itself in the Government report a good character in the year 1850, what certainty is there that in the year 1860 the owners are not raising under the same name a totally different and inferior coal from some other seam, or if from the same seam, taken from a part of it which may be greatly deteriorated by faults in the stratification? Now, unless

the governmental inquiry be made permanent, so as to enable any person to acquire, at a small cost, a knowledge of the commercial value of any coal, it is obvious that this very inquiry may, and indeed must, one day become a source of public deception and fraud. The character of a coal in 1850 is no index whatever of the article which in the year 1860 may be sold under the same name, or supplied from the same pit.

Have we said enough to convince every unbiassed mind that the greatest manufacturing nation in the world requires a permanent governmental inquiry upon the subject of coal? If so, we have gained our end, at the risk of tediousness; if not, then fully impressed with the propriety of the course here recommended, and regretting only our want of eloquence, we will ere long return with renewed energy to the question: meanwhile, leaving the political economy of the matter thus in abeyance, we shall, in our next Number, offer a few philosophical remarks upon the nature and transmission of heat, with special reference to steam-boilers.

NOTES OF AN AMERICAN TRIP IN THE MONTH OF JULY, 1858.

By A London Engineer.

(Continued.)

I was much pleased with the very superior manner in which their boilers were riveted, and with the riveting generally; it is evident that no expense is spared to have it done in the most efficient manner, as well as to avoid forcing the work together by drifts, &c. I saw and examined some locomotive boilers in course of construction, which were quite equal to anything I have ever seen in England: they do not join the barrel of the boiler to the outer fire-box at a right angle, as we do, but use an "inclined plate," making, in my opinion, a stronger job, as it dispenses with the use of angle iron—an article to be avoided in high-pressure boilers.

The engines are very efficient, though they present a strange appearance to English eyes with their bright colours, fanciful paint, polished brasswork, the huge unshapely funnel, and that useful and comfortable appendage, the "cab," which in England is utterly unknown, though within the last few years the use of a "weather board" on some of the narrow gauge engines seems to betoken a desire to make the comfortless position of the men, in winter, more bearable. (On one English line that I know, some drivers were heavily fined for fitting up weather boards on their engines during a severe winter, and obliged to remove them, the plea being that if they were "too comfortable," they would not keep a good look-out!) I took a trip of 140 miles on an engine with one of the express trains, and found this "cab," with the thermometer at 96° in the shade and a blazing sun, to be a most pleasant addition to the engines, and not by any means calculated to increase the number of accidents from the men being "too comfortable," as they were enabled to attend to their work with pleasure, and to keep a good look-out ahead without having their eyes filled with dust and sparks, &c. By means of small glazed doors on each side of the front of the "cab," the driver is enabled to get on the "gangway" round the engine and look to his gear, &c., whilst running, just as easily as if there were no "cab;" this I proved myself several times on both trips, and I did not find the "cab" interfere with the efficient working of the engine in the *slightest degree.*

This engine had the link motion, carried 120 to 130 lbs. steam, and cut off at 3 in. We were running over 35 miles per hour, with eleven cars full of passengers, cutting off at 4 in.; cylinders 16 in. × 26 in. The wood makes a beautifully clear fire, and keeps steam very easily; but the annoyance of the smoke, when stopping at the stations, I found very great. The consumption of wood was $1\frac{1}{4}$ *cord* to 45 miles. This engine, as well as most of the new engines that have been made within the last few years, was fitted with a small air vessel on the feed-pipe, between the pump ram and delivery clack, which makes it work much easier. They use the glass gauge, the three gauge cocks, and Smith's or (Ashcroft's) patent dial gauge, on all their engines, as well as a bell and whistle. This bell is obliged to be rung at all level crossings, and while passing along the streets, under a heavy fine, and quite takes the place of the small whistle on our engines, and the whistle is only used when signalling the railway people. The engine I went with, and all the engines on that line, had wrought-iron framings (some I saw in course of manufacture were very fine forgings, and were finished in a very superior manner), outside cylinders, and flat connecting rods, rather deeper in section than rods of a similar size in England. The engine ran remarkably easy, though the road was to an Englishman in a horrible condition, and the "hammering," from bad joints, &c., frightful. There were no chairs, the metals being merely bolted down to the sleepers by a hook-bolt, similar to a "temporary road" in England; and where the joints of the rails are, a piece of plate-iron, turned over at each end, so as to clip the wings of the metal, and slipped over the joint to confine the ends of the rails, is the only approach to a chair that I saw (what a field for a cheap permanent way company!). I saw no switches or points—nothing but shifting rails; and the freedom from accidents, with such imperfect roads, is to me a perfect marvel, to say nothing of the total absence of semaphore signals, gates at crossings, policemen, pointsmen, &c., &c., which in England are absolute necessities on railroads; and there did not seem to me as much attention paid to the express train, as there would have been to an ordinary coal or ballast train in England. The drivers, however, are well paid (12s. per day), and the guards or conductors have sixty dollars a month.

The cars were very comfortable, all alike—no first and second class, and "cattle trucks," as in England—of great length, and supported at each end on "bogie trucks," with from four to eight wheels each. Between the trucks the frame is trussed with iron tension rods, so that great strength is obtained with little weight, and they are entered by doors at each end. I certainly think the plan of a passage through the centre of the car, which enables the conductor to collect the tickets, communicate with the other conductors and the engine driver, also to pass throughout the whole length of the train during its progress, and see to the comfort of the passengers, should be adopted in England, both from its utility and economy, for it would do away with those nuisances "ticket platforms," their vexatious, troublesome delays, and the chance of being pitched into by the following train while collecting—to say nothing of the great advantage it would give the "*saving system*," by enabling the directors, or others interested, to dispense with ticket collectors at such places.

I am glad to find that the subject of large carriages, and the saving of dead weight per passenger, has begun to excite some attention in England, and the advantages of the system have been in a manner proved on the Ashton branch of the Lancashire and Yorkshire Railway, where two carriages, each 33 ft. long, and with breaks, &c., weighing 16 tons, give better accommodation than the old system of train, consisting of six separate carriages, weighing 30 tons, and seating 149 passengers, while the saving in dead weight amounts to 14 tons per train! These new carriages seat 24 first and 120 second and third class passengers, besides giving ample accommodation for guard and luggage (*vide* the interesting paper on "Saving of Dead Weight in Passenger Trains," by Mr. Charles Fay, of Manchester, in The Artizan for March, 1858).

There is no doubt we should have a great many objections urged against the adoption of large carriages open throughout their length, with a guard every now and then walking through it, and no "exclusive private corner," about which "John Bull" is so particular when he can pay for it; but I feel sure it needs only to be tried for all the *sensible and well-disposed* to give it their cordial support, as being a means calculated to conduce to the safety of railway travelling for the "unprotected female" and the public at large, on account of the facility afforded for finding out anything wrong, and at once communicating with the guard or driver.

In each carriage is a small compartment exclusively for ladies, and also conveniences, such as in England are only found at the stations; and in the winter each carriage is provided with a stove, and can be made as warm and comfortable as desired. There are also stands for sticks and umbrellas, and on some of the long lines they are fitting sleeping berths in the carriages, which may be used on paying a small extra fee.

They use a very ingenious self-acting coupling, which enables a car to be hooked on by simply moving the engine against it. I saw a correct sketch and description of this coupling a few weeks since in the "Engineer."

I had a couple of sea voyages of between 200 and 300 miles in their steamers, which were vessels of about 1,000 tons each, and went on 8 ft. load draft. We made the sea trip of 130 miles in a little over nine hours, with a good deal of sea on, blowing fresh; but the vessel behaved very well, and rolled much less than I expected, for, from her having "guards" extending her whole length some feet beyond her sides, and being high out of water, I thought she would be a little inclined to do so.

Her engine consisted of one 58 in. cylinder × 11 ft. stroke, with the beam overhead above the hurricane deck, as is usual in most of their boats, and supported on wooden frame-work, strongly bolted and tied together with iron rods and straps. The beam is an ingenious piece of iron work, trussed with stout rods, and altogether different from our solid masses of metal used for the same purpose. They are evidently very strong and light, and peculiarly well adapted for their position and purpose. The cylinder stands on the condenser, and the valves employed are equilibrium valves, worked by cams on a rocking shaft connected with the eccentric in the usual manner, and for the injection they use the sluice valve or slide. The engine was easily started, worked, or reversed, by means of a lever, with one hand; and this presented a strong contrast to some boats I have seen, where there are frequently three or four firemen, besides engineers, tailing on to the starting bars! These valves had not been touched for three years, and the boat is at sea five days out of seven. The vacuum-gauge indicated 27 in., and the steam 40 lbs. on the inch while under weigh; whilst stopping, no steam was

blown off, but the furnace doors were opened and the fires were eased by a good feed of coals; nevertheless this did not prevent the steam gradually rising to above 60 lbs. before starting! When under weigh, the fires are urged by fans 8 ft. in diameter, one on each side of the engine-room, driven by a small independent engine; and these fans keep the room very cool and comfortable. The freedom from vibration was very remarkable, which appears to be owing to the close pitch of the floats, there being, I should think, four where we put three; the wheels were about 25 ft. diameter, with 8 ft. floats, and the disturbance in her wake caused by her passage through the water was not as great as the London above-bridge boats usually make; this I particularly noticed. They are built with the long hollow sharp bow of the "wave line," and a good fulness abaft, and I attribute her smooth wake entirely to her form of small resistance and close pitch of floats. The cleanliness and neat and handsome fitting up of these boats are very remarkable, and they afford an immense amount of accommodation and comfort. Each deck is free from bulkheads, from stem to stern, the only obstruction being the enclosure round the engine, in which the staircases to the lower decks are placed; the upper deck is fitted up with small state rooms on each side, and the open part is used as a saloon, having sofas, chairs, tables, carpets, books, looking-glasses, &c., and is lighted by handsome gilt chandeliers, suspended at certain distances from the underside of the hurricane-deck; in this saloon are filters filled with iced water, from which each one helps himself when inclined "free gratis." On the next deck below is the ladies' saloon, kept exclusively for their use, and fitted with berths, &c., in a most handsome and ornamental manner, and plenty of looking-glasses, chandeliers, books, vases of flowers, &c. The other part of the deck was partitioned off for cargo. Below this deck is a large saloon, extending the whole length of the vessel, interrupted only by the engine space, which however left a passage about 6 ft. wide on each side, and fitted up with two tiers of berths for gentlemen, above 400 in number; and at the bow end is a room fitted up with marble slabs, looking-glasses, towels, &c., for washing. This room is also lighted by gilt chandeliers, and presents a very warm and comfortable appearance. In fact, these boats are large floating hotels, exceedingly pleasant to travel in. I was much amused with a notice, in gilt letters, hung on one of the columns which supported the upper deck; it ran as follows:—"*Gentlemen* are requested not to turn in with their *boots on!!*"

RECENT STEAM-BOILER EXPLOSIONS IN THE UNITED STATES.

By An American Engineer.

The numerous explosions which have occurred in Great Britain during the last few months, and been noticed in The Artizan, has induced some of the American journals to draw a comparison between English and American engineering, unfavourable to English boiler construction, but which comparisons are really inconclusive.

The quality of iron employed in boiler construction in Great Britain is undoubtedly but indifferently cared for and attended to by boiler makers; and it is much to be feared, that but for the practice of selling boilers by *weight*, which is commonly followed in England, it is believed that *very many* more accidents from insufficient strength of materials would occur; as it is, it is much to be regretted that the employers of steam power and the makers of steam boilers, both in England and here in the States, do not come to a better understanding as to the supplying of boilers constructed of the best possible, material suited for the purpose, combined or employed in the best possible manner; and that all boilers, before being set to work, be submitted to a proper amount of hydraulic pressure internally, and, whilst in use, to frequent and periodical inspection and testing.

Amongst the most recent accidents which have occurred in the United States in connection with the employment of steam power are the following, which have been extracted from the local newspapers, the names of which are given:—

The "Pittsburgh Evening Chronicle," August 3rd, states that the steamer *Falls City* burst a cylinder cover a few days ago on the Mississippi, about 35 miles below Memphis. Three men and a boy were blown overboard. The men were drowned, the boy was recovered, but died shortly afterwards from his scalds. Seven others of the crew were scalded, two of whom were not expected to survive.

August 7th (from the "Philadelphia Press" of August 14th).—The steamer *Virginia* blew up at New Orleans on the morning of the 7th inst. The mate was killed, and several others severely scalded; and the "New Orleans Picayune," of August 7th, states that since their last issue, six persons have died from injuries received from the explosion on the *Virginia*. The same paper, of the 11th August, says that the mangled remains of the cook were found yesterday on board the *Virginia*.

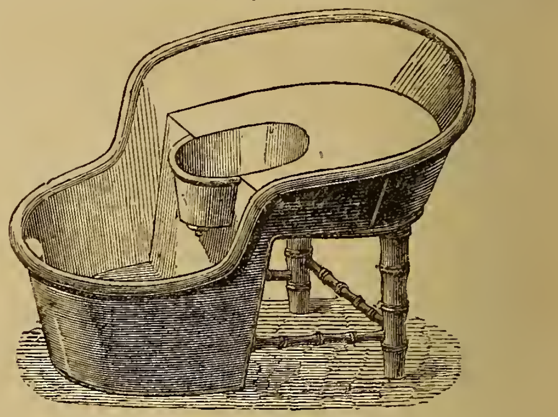
August 15th (from the "Boston Journal," August 15th).—At about four o'clock this morning the boiler connected with Dexter Brothers' cotton mill, at the corner of Pleasant and Main Streets, in Powtricket, exploded, tearing the building in which it was located into fragments. An adjoining building, occupied as a drug store, was rendered almost a complete wreck. The mills took fire, and all but the walls was destroyed. A fireman was much injured, but probably not fatally. A boy was taken out of the ruins, but was living at last accounts. The cause of the explosion was a lack of water in the boiler.

These accidents are the only ones which have been reported in the newspapers which have come under the observation of the writer during a fortnight; but it must be conceded that, considering the relative proportions of steam power employed in Great Britain and in the United States, and that these accidents have occurred in a very few days, there is no room for self-congratulation on the part of our American engineers.

OXLEY'S MULTUM-IN-PARVO BATH.

[Illustrated.]

The above illustration shows a very simple and exceedingly valuable improvement in the construction of the most important of all domestic conveniences and requisites for health-maintaining purposes,—the bath. Cleanliness is said to be next in degree to godliness, and anything which renders the attainment of daily ablution more easy, agreeable, and inexpensive, and more consistent with the economy and arrangement of general domestic life amongst the less wealthy and luxurious classes, should be hailed as a great boon to society at large. How many are there, not only of the labouring class, but also, we fear, amongst the middle class, who daily immerse the whole of their persons in water? We really fear there are, indeed, but few. The chief cause of this much to be deplored but consequent state of bodily uncleanliness, is the almost impossibility of any but a wealthy or well-to-do person being able to afford the first cost of a reclining bath, and also that the very large quantity of water requisite renders it difficult to be readily obtained without the assistance of servants, or the cost of extra water-service; or, some other interfering cause steps in to render it difficult, expensive, troublesome, or impossible.



The great disadvantage of the ordinary hip bath is, that it does not permit of the feet being immersed simultaneously with the posterior portion of the body, and the position of the bather is not the most favourable for cleansing the upper parts of the person.

Oxley's bath is only about the size of, and in appearance externally very much like, the ordinary hip bath, and being quite portable, may be kept in the bed-room or dressing-room; the small quantity of water which is necessary for enabling a complete and thorough cleansing of the person to be performed, renders it capable of almost instantaneous use, independently of any assistance from servants. In using the bath, the bather sits upon the seat, with his feet in the lower part, or foot-bath portion, very much as if sitting in an arm chair, the splayed sides preventing splashing over. The seat has a movable pool or dish, which is used as a sponging bath, or a bidet, and which, upon being removed, allows of the lower part, or foot-bath portion, being used as a hip bath; thus Oxley's bath combines in one and the same apparatus, a sponging bath, a foot bath, a hip bath, and a bidet; and, by the addition of a pump and the usual poles and fittings, it may also be used as a shower bath. Now, a great domestic convenience such as this, commends itself directly to the serious and immediate attention of every one who values health,—and there is no better promoter of bodily health than daily ablutionary exercise,—and this is, by Oxley's new bath, rendered quite practicable for those to whom it was before absolutely impossible.

ROBERTS' PATENT FRICTION WINDLASS.

(Illustrated.)

Mr. Richard Roberts, of Manchester, the well-known engineer, has introduced an excellent arrangement as a substitute for the ordinary windlass and capstan used on board of ship, as also for the ordinary kinds of crabs and apparatus for raising and lowering heavy weights.

The machine is certainly simple, and if the framing and working parts be made of sufficient strength to withstand the great and sudden strains and rough usage to which it is certain to be subjected when used at sea, or when employed for holding a ship at anchor in a storm, or during a gale on a leeshore; and if, as the inventor states, its employment supersede or render unnecessary the use of "compressors" or "stoppers," and if the "paying-out" and "holding-on" a ship's chain cable can be safely effected under the most unfavourable circumstances, the very great advantages which would thus be secured will recommend its employment in preference to all other contrivances at present in use.

Fig. 1 is a plan, and Fig. 2 a side elevation, of a double purchase friction windlass: *a a* the framing; *b b*, the square ends of the two shafts for receiving the handles; *c c*, the two barrels, each having four grooves therein. These barrels revolve freely in bearings in the frames, whilst the two first-motion shafts, *b*, pass through the hollow centres of the barrels, and work in suitable bearing-brackets projecting from the sides

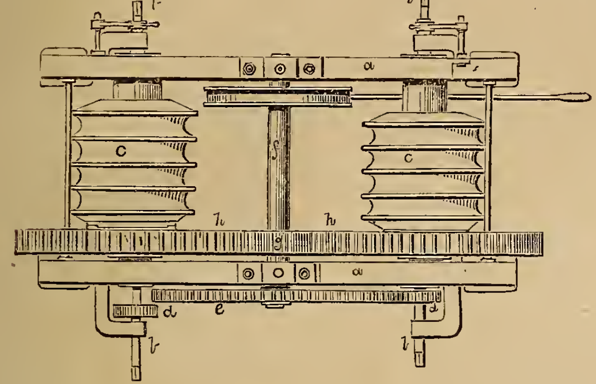


Fig. 1.

of the frames, and which brackets permit of the pinions, *d d*, being pulled into or out of gear, as shown in Fig. 1. The pinions, *d d*, take into and drive the spur-wheel, *e*, which is keyed on to the shaft, *f*, and a pinion, *g*, is likewise keyed on to the same shaft, which takes into and drives the spur-wheels, *h h*. These spur-wheels may be connected to the barrels, *c c*, by means of clutches or otherwise.

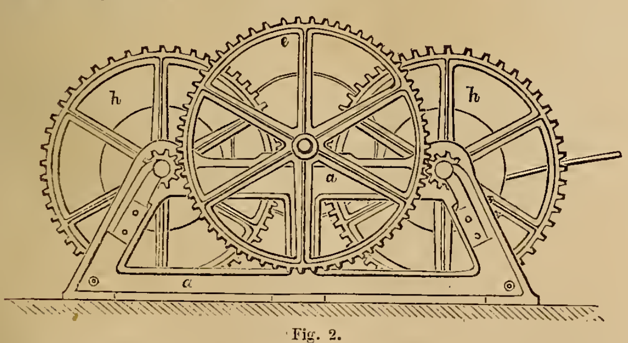


Fig. 2.

A brake-wheel or drum is keyed on to the shaft, *f*, and is fitted with a brake-lever and strap, as shown.

The chain-cable or rope passes first over the first groove in one drum, then passes over the opposite groove of the other drum, then back again, and so on, somewhat as in two multi-sheave blocks—except that the several grooves are formed in the same drum, and are not independent and free to revolve separately, thus forming a very powerful means of regulating perfectly the rate of descent whilst lowering out heavy weights.

These friction windlasses, as made by Messrs. S. Ellis and Co., of Irwell Works, Manchester, are, as it appears to us, destined to take the place of many of the machines at present in use for raising and lowering heavy weights. Amongst the advantages which Mr. Roberts claims for this contrivance are the following, viz.:—

1. No "ranging" of chain is required. 2. The dangerous process of "rendering" chain to the windlass is dispensed with. 3. The anchor may be cast, or more chain payed out at a moment's notice, under all circumstances. 4. The descent of the anchor is under the absolute control of one man. 5. It is a far more expeditious means of "getting" the anchor. 6. The capstan and messenger are dispensed with. 7. No stowing of the cable is required. 8. "Riding-turns" are impossible. 9. It occupies far less space. 10. It is a far more powerful purchase. 11. "Fleeting" the chain is no longer necessary. 12. Any length of chain or rope may be used without a second lap. 13. It may be used for a variety of purposes in-board. 14. It is simpler, easier to repair, far stronger, and much less liable to derangement.

TRANSACTIONS OF THE INSTITUTION OF ENGINEERS IN SCOTLAND.

ON THE NAVIGATION OF CANALS BY SCREW STEAMERS.

By Neil Robson, C.E.

(Illustrated by Plate cxxxii. and also by Woodcuts.)

It is not the object of this paper to go into any lengthened history of the various modes of haulage which have been tried on canals in general; but rather to collect and make known to the members of the Institution some facts connected with recent successful attempts to introduce screw-propulsion on the Forth and Clyde Canal, with which the author is best acquainted, and which, as is well known, is one of the principal arteries of inland navigation in Scotland. And by so doing, to direct the minds of the ingenious mechanical engineers of which the society is composed to the great importance of the subject, and to elicit opinions as to its farther development, with a view to improve the mechanical details and arrangements of the power employed.

But whilst this is the chief object of the author in bringing the subject before the Institution, he will venture to digress so far as to introduce a few preliminary observations on inland navigation in general, and will briefly notice a few of the English canals on which this new mode of haulage has been tried and is now in use. The several experimental attempts which have been made to introduce other modes of haulage on the Forth and Clyde Canal will then be given somewhat in detail, and the paper will be brought to a close by a description of the system now being introduced on that canal; reference being made to drawings illustrative of the boat *Thomas*, and her engine, with which the first really successful experiment was made under the Canal Company's more immediate control, with the advice and under the superintendence of their officers. In the concluding remarks the author will contrast the expense of horse and steam haulage, as brought out by the results so far as they have gone.

It cannot be denied that since the introduction of railways, canals, which prior to that event formed the principal mode of conveyance for a very large proportion of the goods and mineral traffic of the country, have been thrown into the shade; and that the attention of practical men has been more devoted to the development of railway traffic, not only as regards the mechanical appliances for its transit, but also as regards the acquisition and carrying of large quantities of merchandise and minerals, than to the improvement of the more ancient mode of conveyance.

There is no good reason, however, why this should be so; for although in some cases, canals may be the avowed rivals of railways, in others they are or might be made the means of feeding their traffic, or of relieving them of a portion of the heavy merchandise and mineral traffic which railways cannot always carry with advantage to themselves. It does not follow that, because a railway may be carrying a large amount of tonnage, it is doing so profitably; on the contrary, it is to be feared that in many cases, if the cost were fairly set against revenue, the result would be found quite the reverse; the rates obtained being inadequate to meet the greater wear and tear of the iron road, as compared with the water-way, and the many sources of expense to which railway plant is subjected. For passengers, and for light and perishable goods, and for goods requiring quick dispatch, canals never can nor ought to compete with railways, but for bulky and heavy goods and minerals, the author is convinced that they can and will maintain their ground, provided their managers keep pace with the improvements and requirements of the day.

In Great Britain and Ireland, the total length of canal and inland river navigation is about 4,000 miles; and it is estimated that there has been expended in the construction and improvement thereof at least £50,000,000 sterling. These figures of themselves sufficiently demonstrate the importance, in a national point of view, of this great interest.

For the most part, canals carry on toll; that is to say, they are open to any trader, however small, who chooses to send his own boat with horses to tow it, on payment of the fixed rate of toll, and in this respect they are similar to turnpike roads. In a few instances, canal companies act as carriers on their own account, but it is questionable how far they do wisely in this. It consists with the author's knowledge that the Forth and Clyde Company, who ceased altogether to be carriers about five years ago, except to a very small extent, have made more money by

falling back on their simple province of keeping the canal in repair, and acting as recipients of toll.

It appears that the first attempt to propel boats by the screw on the English canals was made about twenty years ago between London and Manchester; but from the great number of locks—there being about one to every mile—and from the narrowness and want of depth of the canals which compose that route, it was not so successful as to lead to any practical result at the time. Within the last three or four years, navigation by screw-boats has been introduced on the Aire and Calder navigation—on the Leeds and Liverpool canal—and on several others in that country; and so far with success. The best practical result, as regards speed and economy of working, is obtained on those canals of which the depth is not less than 6 ft., breadth at water level 50 ft., and at bottom about 35 ft.; but as the majority are of less size, it is to be hoped that the time will come when screw propulsion may be applied with advantage on our shallowest and narrowest canals; and to that end, the bringing of the subject to the notice of such meetings as this will no doubt tend.

The first attempt to move a vessel by steam on the Forth and Clyde Canal was made about the beginning of the present century, and it appears that Mr. Symington was connected with the fitting-up of the boat. This boat was propelled by two paddle-wheels, close together at the stern, with the driving cranks between them. It ran for some little time; but its chief merit was considered to lie in its being an ice-breaker, for which it answered admirably. Although the records of the canal do not mention the fact, there can be little doubt that this was the *Charlotte Dundas* constructed by Symington in 1802, and with which he made one of his first essays in steam navigation.

In 1828, the *Cyclops*, a boat for carrying passengers, was fitted up as a steamer with paddle wheels at the stern. She was 64 ft. long, 16 ft. broad, and 6 ft. deep, carried about 40 tons of goods, and went about $3\frac{1}{2}$ miles per hour on the canal, and about 6 miles on the Firth of Forth.

In 1831 the *Manchester* steamer was built, propelled likewise by one wheel at the stern. She carried from 50 to 60 tons of goods, and steamed about $4\frac{1}{2}$ miles on the canal, and 7 miles on the firth.

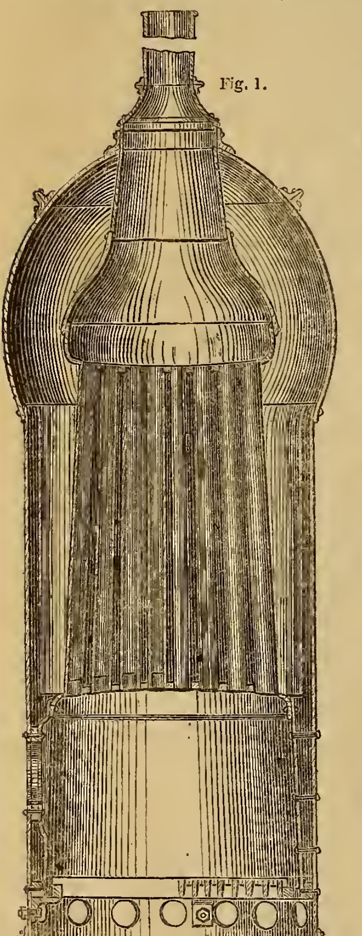


Fig. 1.

The *Lord Dundas* was also built in 1831 as a passenger boat. She had two paddle-wheels, one on each side of the stern, and steamed about $7\frac{1}{2}$ miles an hour on the canal.

All these boats ceased to be used on account of the cost of working being greater than horse haulage, and from constant failures in the machinery.

It was proposed at one time, and actually tried, to haul vessels on the canal by laying a chain along the bottom, to be acted upon by a pulley in the boat, the pulley being worked either by hand or steam power.

Another experiment was the laying down a line of railway on the towing path, on which a locomotive engine ran and hauled boats behind her; a previous trial for hauling them by a locomotive for common roads running on the towing path having signally failed, as might reasonably have been expected.

In 1844 a Mr. Kibble patented a paddle-wheel composed of a number of float-boards fastened on an endless chain, working round two drums. It was thought that this mode of propulsion was well adapted for canals, and a boat fitted with a paddle of this description on each side was tried, but given up on account of the expense.

The late Mr. Smith, of Deanston, had a plan which he intended for the small canals in the West India Islands, of having a wheel passing through and projecting below the bottom of the boat, so as to run on the bottom of the canal, and thus haul the boat. This plan was tried on a reach of this canal about ten years ago, but did not answer.

In addition to these, the author understands that several attempts were made to introduce steam on the Union and Monkland Canals, which communicate with the Forth and Clyde Canal, but are of less depth and width. In 1846, a steamer with double screws was tried on the Union. In 1845, a steam tug, built by Mr. William Napier, jun., was tried on the Monkland Canal.

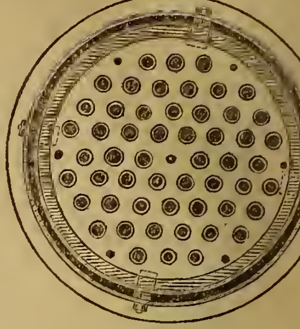


Fig. 2.

From some cause or other, it appears that all these attempts, not only on the Forth and Clyde, but on other canals running into it, were more or less failures; and that it is only within the last two years that anything like a systematic carrying out of steam propulsion has been accomplished. The available depth of water on this canal is about 8 ft. 6 in.; average width at water surface, 60 ft.; and at bottom, 30 to 40 ft. Its length is 39 miles, and there are 40 locks, the dimensions of which are: length, 70 ft.; width, 20 ft.; and least depth on sill, 9 ft. 4 in. The Monkland Canal, now amalgamated with it, is 12 miles long, but its available depth is only about half that of the Forth and Clyde; width at water surface, 40 to 50 ft.; and at bottom, 25 to 30 ft.; length of lock, 70 ft.; width, 13 ft. 6 in. The total merchandise and minerals conveyed on the main canal and its Monkland branch is upwards of two millions of tons per annum.

At present there are five screw-steamers, belonging to different traders, daily at work on the main line, and one belonging to the Canal Company, who are also fitting up another with screw-machinery to serve as an ice-breaker, and have drawings in progress for engines to be fitted to a canal and sea-going steamer.

The lighter *Thomas*, to which this Paper more particularly refers, was not originally built for being fitted with the screw, nor is she of a class adapted for going out into the firth, but nevertheless she may be taken as a fair sample of a large class of lighters in use on the canal. She is 66 ft. long, $16\frac{1}{2}$ ft. broad, draws about $6\frac{1}{2}$ ft. of water, and carries from 70 to 80 tons of cargo. The screw lighters belonging to the traders are larger, and are fitted to navigate the firths of Clyde and Forth as well as the canal, and carry from 100 to 120 tons of cargo.

The engine and boiler of the *Thomas*, as will be seen from the engraving, Plate cxxxii., are placed in the stern behind the bulkhead, which partitions off the stern portion to the same extent as the stern portion of the other lighters of the class which are used for horse haulage; and this space, small though it is, is found amply sufficient for the boiler, engine, and coal bunker, with room for attending the engine and stoking the boiler. Fig. 1, Plate cxxxii., is a longitudinal vertical section of the after part of the *Thomas*; Fig. 2 is a transverse vertical section taken immediately behind the boiler; and Figs. 1 and 2 (woodcut) are vertical and horizontal sections of the boiler, the latter being taken at the fire-box tube plate. The weight of the engine, boiler, and propeller, including 13 cwt. of water, does not exceed 3 tons. The dimensions of the boiler and engine are as follows, viz.:—

Inside diameter of body of boiler, 3 ft.; and swelled to 3 ft. 5 in. at surface water line. Height of boiler from fire-bars to crown, 7 ft. 3 in. The boiler is furnished with 54 brass tubes of the average length of 3 ft. 5 in.; and tapered from $2\frac{1}{4}$ in. diameter inside at the fire-box tube plate, to $1\frac{3}{4}$ in. inside diameter at the uptake tube plate; which gives the heating surface in fire-box and tubes as follows, viz.:—

	Sq. Ft.
Fire-box, 2′ 6″ × 1′ 6″	11·78
,, Tube-plate	2·54
Total fire-box surface	14·32
54 tubes, 3 ft. 5 in. long, and 2 in. average diameter	96·60
Total heating surface	110·92

	Ft.	in.
Diameter of cylinders		$6\frac{1}{4}$
Stroke of piston		10
Valves worked by link motion, extreme throw		3
Diameter of screw-propeller	3	6
Pitch of screw	4	0

The engine cylinders are bolted together, forming the steam-chest between them, in the usual way. The cylinders lie on the bilge of the lighter, and their connecting rods are attached directly to cranks at right angles to each other on the engine-shaft, which is coupled to the propeller shaft. The screw of 4 ft. pitch, at 130 revolutions per minute, gives a speed of 5 miles an hour, while the advance of the screw due to the speed is 5·909 miles per hour, showing a slip of the screw of 2-13ths.

It is found that 35 lbs. per square inch of pressure in the cylinders is

sufficient for propelling the lighter with a full cargo of from 70 to 80 tons. In breaking through the ice on the canal in December, 1856, the boiler was worked up to 85 lbs. pressure, and at that pressure the boiler was more than capable of supplying the cylinders with steam. The contracted area of the water surface gave rise to a suspicion that the boiler might be liable to prime, and after some experiments with a glass model boiler, it was resolved to fit in a current plate round the inside of the boiler shell. Without estimating the merits of the current plate, it may be stated that the boiler is quite free from priming with the steam taken from the crown with a 1½ in. pipe. The taper tubes were deemed a desideratum, with the view of obtaining an increased influence from the fire throughout the short distance it has to pass from the furnace to the uptake, and also to allow the upper tube plate to be reduced in diameter, thereby increasing the surface of the water in the boiler.

On a late trial of four trips from Port-Dundas to Bowling (a distance of 12 miles) and back, making a distance of 96 miles run, passing through 144 canal locks, and getting up steam eight times, the consumption of coal (good Monkland soft coal) was 1 ton 3 cwt., which, at average length of runs on the Forth and Clyde Canal, might be stated to be equal to 100 miles steaming by 1 ton of coals.

As the engines were fitted to the lighter as an experiment, it was deemed desirable to make them of sufficient power to tow another lighter of similar size, which they are quite able to do; but the traffic the lighter is at present employed in does not afford opportunities for using the surplus power in towing.

The boiler has been proved to be so capable of raising steam, that the Canal Company have contracted for two similar boilers with iron tubes, to supply steam for two 9½ in. cylinders with 15 in. stroke of piston. These are to be fitted to an ice-breaker, which is also used for the service of the canal works.

The lighter has been constantly at work for the last 15 months between Port-Dundas and Bowling, a distance of 12 miles, carrying general merchandise in connection with the Dumbartonshire Railway, and without losing a single trip through any accident, injury, or repair of the machinery. The only alteration made in the engine was the substitution of cast-iron valves for brass valves, and the only mishap which has befallen any part of the working gear was the breaking of one of the arms of the screw propeller. She can easily make three trips a week, and usually performs the voyage each way in four hours, when not detained at the locks by the passing trade; which, including the detention in passing through the 18 locks, is at the rate of 3 miles an hour; but when fairly clear of the locks, her average speed is 5 miles per hour.

There is very little additional swell, or washing of the banks, at this speed, and, on the whole, there does not appear to be any appreciably greater wear and tear of the canal than that arising from the passage of boats drawn by horses; at all events, no more than would be compensated for by the saving in upkeep of the banks, in having no towing path to uphold, were horse haulage done away with.

Altogether, the result proves that by means of the screw the navigation of canals by steam is perfectly practicable. But it is still doubtful how far this power can be applied to propel, with advantage, more than the boat in which the engine is placed, owing to the difficulty of steering boats towed behind, especially in narrow canals; and to the circumstance that when the tug, with its train of boats, approached a lock, each would have to be disconnected and taken through singly. The Author inclines to the belief that, as a general rule, an engine must be put in each boat. That this can be done to advantage with boats for goods he thinks has been proved; but the problem is still to be solved whether the system can be profitably applied to boats carrying minerals alone on such canals as the Monkland, of which the available depth is only 4½ ft., and the width proportionately small. These boats, or "scows," as they are termed, carry on an average 55 tons; are in length 66 ft.; width, 13 ft. 4 in.; cost, built of iron, about £250; and are usually hauled by one horse. The speed when loaded is about 2 miles an hour clear of the locks, and going back empty it is a little more.

It is obvious that if every such coal boat must have an engine for itself, three things will be required:—1. The machinery must occupy little room, in order to leave space for the cargo. 2. The first cost must be small. 3. Its working must be economical, both as regards repairs and consumption of fuel. The Author does not despair of seeing all these accomplished, and hopes that the time is not far distant when the haulage, even of coal "scows," will be done more cheaply than by horses.

Meantime, he wishes it to be understood that the following comparisou of the cost of the two systems applies exclusively to the results obtained from the experiment with the *Thomas*, running to aud from Bowling with goods; and being somewhat in favour of steam, may be accepted as a good omen that better results will yet be obtained. For although this portion of the canal is favourably adapted for steaming, so far as depth and width are concerned, yet, owing to the great number of locks, and detention there, it is, in other respects, less favourably adapted than other portions where the reaches are longer and the locks fewer.

Comparison of Cost of Horse and Steam Haulage.

Horse Haulage to and from Bowling. Goods Lighter.

One master, per week	£1 1 0
One mate, do.	0 18 0
One horse and one man tracking, and making two trips per week	1 8 0
Ropes for tracking	0 2 0
	3 9 0
Add interest on cost of lighter, £450, at 5 per cent., and for repairs and depreciation, 7½ per cent. on same amount, per week	1 1 7½
Total per week	£4 10 7½

Thus, at two trips per week, £4 10s. 7½d. ÷ 48 miles gives 1s. 10½d. as the cost per mile per boat load of 75 tons, or 3-10ths of a penny per ton per mile.

The same with Steam.

One master, per week	£1 1 0
One mate, do.	0 18 0
One engine driver, do.	1 0 0
Oil, tallow, and gasket, do	0 3 8
15¾ cwts. coals per week	0 5 6¼
	3 8 3¼
Add interest on cost of lighter, £450; engine, £320; together £770, at 5 per cent., and 7½ per cent. on same sum for repairs and depreciation, amounting per week to	1 17 0¼
Total per week	£5 5 2½

Thus, at three trips per week, £5 5s. 2½d. ÷ 72 miles gives 1s. 5½d. as the cost per mile per boat load of 75 tons, or 23-100ths of a penny per ton per mile.

From the slow rate of trackage by horses, no more than two trips per week are got, while with steam three trips are easily made; and hence arises a very considerable part of the above saving in favour of steam power.

From these figures it appears that the cost by steam haulage is at the rate of 17·5 pence per boat load per mile, or 23-100ths of a penny per ton per mile; and by horse haulage 22·5 pence per boat load per mile, or 3-10ths of a penny per ton per mile; including, in either case, an allowance for tear and wear, and repairs and interest on the price of the boat, and the same on the machinery in the case of steam. These rates are calculated on the supposition that the full load of 75 tons is carried both ways; but as that will not always be so in practice, the cost will generally be somewhat higher, whether by steam or horse haulage. And when the boat is only loaded in one direction and comes back empty, the cost will, of course, be still higher.

Mr. Robson remarked, that the Paper showed how the navigation of canals by steam had been effected at a less cost than by horse-haulage in one particular instance. It would be observed that in the *Thomas*, with which this result had been obtained, the engine and boiler were put into a very small space at the stern. If, however, steam power was to be rendered applicable to canals of very small depth, like the Monkland, the engine and boiler would have to be squeezed into a still smaller space. He confidently expected this would be done, and it was one of the objects of his Paper to bring this point before the Institution, in the hope of eliciting a suitable plan from some of the ingenious mechanical engineers amongst its members. If the system was to be applied to coal scows, it was necessary that the engine, boiler, and propeller, should not cost more than £150. Mr. Milne, the superintendent and engineer of the Forth and Clyde Canal, was present, and would be glad to answer any questions.

ON A SCREWING MACHINE.

By Mr. S. M'Cormick.

(Illustrated by Plate cxxxii.)

Some years since, the writer being extensively engaged in manufacturing screw bolts and wood screws for railway fastenings, was much troubled with continual stoppages, arising from breakage and rapid wearing out of the screwing apparatus. The constant annoyance and expense attending the old system, led him to search for some other mode of screwing; and it occurred to him, that if bolts could be screwed whilst the material was redhot, a great saving would be effected, and the annoyance removed. The idea of rolling with three rollers suggested itself, and a small machine was immediately made, with which, after a great many trials and failures, he succeeded in making screws of both fine and coarse threads with considerable facility. At this stage, the matter was laid aside for a considerable time; but in 1853, a favourable opportunity offering, further experiments, with improved machines, were made, and the plan was fully tested and proved to be really practicable.

The machine before the meeting is one of the latest, and certainly one of the best made according to the writer's system, and he thinks that as far as it goes, it admits of little if any improvement. Several additions have suggested themselves, but these have for their object merely to facilitate the insertion of the blanks, and to determine the length to be screwed; they are all of an automatic character, and would make the machine almost entirely self-acting. The operator would only have to lay the hot blank in a receptacle provided for it, and to move a small engaging lever. These additional contrivances can be applied to this or any other of these machines.

The distinguishing feature of this machine is, that it forms the screw threads whilst the material is redhot, by simple rolling. In the ordinary screwing machines the threads are cut out of the material; in this they are formed by simple pressure, and there is consequently no waste. It will be readily understood that the operation must be performed with great rapidity, otherwise the cooling of the material would render it impossible. The rolling matrices or dies move at the rate of about 180 revolutions per minute, and being at least three times the diameter of the screw or bolt, the latter will make 540 revolutions in the same time. Suppose a wood screw to have 15 turns in $2\frac{1}{2}$ in., it will require 30 turns to screw it, and will take 1-18th of a minute, so that such screws would be screwed at the rate of 18 per minute. In practice, however, not more than one-half of this number can be completed in the time, as it requires more time to put the bolt into the machine than to screw it. From 2,000 to 6,000 per day may be stated as the performance of one machine, but the number altogether depends on the size and length of the screws. Besides rolling screws, the machine is well adapted for rolling iron or other metal into ornamental or useful shapes. The writer is informed that there are some small machines so employed in the vicinity of Birmingham. A few rough experiments were made to try the comparative strength of bolts made on this principle, and common bolts. A hole of the length to suit the bolts to be tried, was drilled through a piece of metal. The bolt was put into the hole and screwed up until it gave way, and either broke or had the thread stripped off. All the hot-screwed bolts were broken, the others stripped. These bolts were of the same kind and size, made from the same bars, and by the same workmen.

The working part of the machine substantially consists of three spindles mounted in brasses of a peculiar form, which will be understood by examining the drawings. One end of each of the spindles is formed into a toothed pinion cut out of the solid. The other end is prepared to receive a matrix or die, and each has turned on it a spherical bearing near the pinion end. The spindles are shown in Fig. 6, Plate cxxxii.; and in section, and numbered 1, 2, 3, in Figs. 7 and 8. The brasses in which these spindles work are placed in the front pedestal, B, of the frame, Figs. 6 and 7, and are constructed so as to be adjustable to all the angles and distances of the spindles required to suit the different sizes and pitches of the screws, being fixed by set screws. A pedestal, C, Figs. 6 and 8, supports the graduated plate, in the centre of which is fixed the brass forming the bearing for the three die spindles. This plate partially revolves in the pedestal, and carries round with it the three spindles, which assume a twisted appearance in turning with each other. It is to admit of this twisting that the journals of these spindles are made spherical, no other form being suitable. Each pitch and diameter of bolt requires an angle of its own, which is found by applying a directing screw of the pitch and diameter required to the under side of the upper or central die, and turning round the graduated plate until the screw is parallel to the central line of the machine.

Motion is communicated to the machine by two pulleys, D, E, Fig. 6, driven by separate belts in opposite directions. The insides of the rims of both these pulleys are turned conical, corresponding in taper to the rim of the internal pulley, F. This pulley, F, is connected to a hollow shaft, G, Fig. 6, by a broad cotter which passes through an elongated slot in the shaft, and also through the spindle, H. This spindle, H, is fitted loosely in the hole in the shaft, and is connected by a peculiar coupling to the end of a bent lever, I, thus connecting the pulley, F, by means of the spindle, H, with this bent lever, the end of which extends beyond the front of the machine a sufficient distance to allow the operator to depress it with his foot. At J, Fig. 7, is a catch jointed on the front of the machine, and actuated by a slight spring, and having two notches cut in its edge, to retain the bent lever in position. When the lever is placed in the upper notch, the pulley, F, is then in a central position, and the machine is at rest. When the lever is placed in the lower notch, the pulley, F, will be in contact with the pulley, E, and will revolve with it; and when the lever is released from the catch altogether, it will be elevated by the spiral spring, and the pulley, F, will then be brought into contact with the opposite pulley, D, and will revolve with it in the reverse direction. A toothed pinion, seen in section at K, is keyed on the shaft, G, and drives the large toothed wheel, which is keyed on a shaft, L. On the end of the shaft, L, is cast a hollow case, M, Figs. 8 and 9, in which is keyed an internally toothed wheel, gearing into and driving the three die spindles simultaneously.

In making a screw, the operator first pushes down the bent lever, I, into the lower notch of the catch, and the machine then revolves in the direction which screws the bolt inwards. He then puts a bolt, N, Fig. 6, into the central opening between the dies, pulls down the handle with his left hand to a regulated stop, which depresses the upper die upon the bolt, whereupon it immediately turns, and is screwed inwards by the simultaneous revolution of the three dies as far as the thread is required. The operator then with his toe touches the catch, which releases the bent lever, and the spring instantly elevates it, whereby the pulley, F is pushed into contact with the opposite pulley, D, and the motion of the machine is reversed, so that the bolt is screwed out, and when released from the guide, drops upon a shelf or other receptacle. During the operation a stream of water is constantly running on the dies.

The furnace in which the bolts are heated should be close to the machine, so that as little time as possible be lost in handing them from it to the machine. The heat required for bolts is not high—just fairly red; that for wood screws is higher—a brighter or full red.

The matrices, or dies, for coarse threads or wood screws, are best made of cast iron, cast in a chill mould; those for fine threads of cast steel or malleable iron, case-hardened.

The machine before the meeting is constructed for screws of from $\frac{1}{2}$ to $\frac{3}{4}$ in. diameter. Machines may be made, however, to screw from $\frac{1}{4}$ in. upward. The following are some of the advantages claimed for this mode of making screws:—Additional strength acquired by the peculiarity of the operation; saving of waste (in wood screws this amounts to 15 per cent. of the finished weight), the whole quantity cut away in the common way being compressed into the screw; great rapidity and facility of production; saving of all antifrictional material, such as oil; non-requirement of high-priced labour, three trained boys only being needed.

DESCRIPTION OF THE GREAT WEST OF SCOTLAND FISHERY COMPANY'S STEAMER "ISLESMAN."

By Mr. J. R. Napier.

(Illustrated by Plate cxxxii.)

This vessel was designed for carrying live fish from distant fishing stations to market, and as speed was not very important, if the fish could be kept alive and in healthy condition for about a week's voyage, it was not thought necessary to aim at a greater rate than 8 nautical miles per hour. This speed has been attained in the *Islesman*, whose dimensions are—length on the water-line, 105 ft.; breadth, 20 ft.; and depth, $12\frac{1}{2}$ ft. Shortness was considered to be a good quality for manœuvring in the narrow creeks where it was possible many of the Company's best stations might be, and breadth is, undoubtedly, a good quality where the wind is frequently to be taken advantage of as a propelling power. With this in view, two masts were provided—not for appearance, but for use—with three fore and aft sails, it being considered that as these sails were so easily worked with few men, they would be more frequently set and do more duty than any other kind. The Company have lately altered the rig, thinking it necessary to do so in order to deliver their cargoes above the Glasgow Bridge. Still, however, the original rig has the most advantages. There is no peculiarity in the form of the vessel to require notice. The arrangements, however, for carrying the live fish are, I believe, new. Though I am not sufficiently acquainted with former arrangements of welled smacks to describe them minutely, I believe one or two bulkheads divided them into compartments, and small holes were formed in the bottom of the vessel to the sea. These compartments or wells were constantly full of water, and the circulation of the water for the preservation of the fish depended on the motion of the vessel. The water went out at the small holes when the vessel rose out of a wave, and a fresh supply entered when she sank into a wave. In calm weather, however, when there was no such motion, I understand the fishes frequently died. The arrangements of the *Islesman* were specially designed to prevent the death of the fishes in calm water, or when the steamer was at rest in a port, and also to get the full use of the vessel when there might be no live fish to carry, but plenty of dry cargo.

Fig. 3, Plate cxxxii., is a longitudinal vertical section of the *Islesman*; Fig. 4 is a transverse vertical section through the engine-room; and Fig. 5 is a transverse vertical section through one of the fish tanks or wells. The vessel is divided into seven water-tight compartments—three of these are the tanks for the live fish—the mode of construction being seen in Fig. 5. At the fore-part of each tank a sluice opens a passage to the sea, the orifice of which has a cover formed with small holes to prevent the ingress of molluscs, &c., and the egress of the confined fishes. A large pipe from the bottom of each tank, and connected to a centrifugal pump in the engine-room, completes the arrangement. The wells at the load-water line have a capacity of about 3,000 cubic ft., and it was considered advisable to have a pump of sufficient power to discharge this volume every ten minutes, or 300 cubic ft. per minute. Professor James Thomson, of Belfast, was applied to and gave the design of a pump, which has fulfilled every expectation. This pump is seen in Figs. 3 and 4, and is shown drawn to an enlarged scale and in vertical section in Figs. 10 and 11, Plate cxxxii.: whilst the following description, which Professor Thomson has kindly supplied, explains its action.

DESCRIPTION OF PROFESSOR THOMSON'S CENTRIFUGAL PUMP.—"In centrifugal pumps, when doing actual work in raising water or forcing it against a pressure, the water necessarily has a considerable tangential velocity on leaving the circumference of the wheel. This velocity in wheels in which the vanes or blades are straight and radial, is the same as that of the circumference of the wheel; in others, in which the vanes are curved backwards, it is somewhat less; but in all cases it is so great that the water on leaving the wheel carries away, in its energy of motion, a large and important part of the work applied to the wheel by the steam-engine or other prime mover. This energy of motion in centrifugal pumps and centrifugal fans, as ordinarily constructed, is mainly consumed in friction, and eddies in the discharge pipe, which receives the water or air directly from the circumference of the wheel. In the improved centrifugal pump there is provided, around the circumference of the wheel, an exterior chamber, in which the water continues some time revolving in consequence of the rotatory motion it has on leaving the wheel. This chamber is called the exterior whirlpool chamber, and is ordinarily about double the size of the wheel in diameter. The water revolving in this chamber is in the same condition as water revolving in the whirlpool, which I have called the Whirlpool of Equal Energies, or Free Mobility. In this whirlpool (when some slightly modifying causes, such as the fluid friction, are neglected) the velocity of the water is inversely proportional to its distance from the centre, and the sum of the accumulated work or energy of motion aud the work in the condition of water pressure of two equal masses of water in the same horizontal plane is the same, so that when the velocity dimiuishes, the pressure increases: the energy of motion given up in the diminution of velocity being converted into water pressure. It is by this conversion of energy of motion into water pressure, through the medium of the exterior whirlpool, that a decided increase in the working efficiency of the centrifugal pump is attained; the work contained in the rapid motion of the water leaving the wheel, which in centrifugal pumps as ordinarily constructed is wasted, being in the improved pump usefully employed in increasing the pumping power of the machine. In connection with the description of the pump, it may here be added, that in fixing on the dimensions of the pipes, it was kept in view not to make them, on the one hand too large or too heavy for the convenience of the vessel, nor, on the other hand, too small for conveying with sufficient freedom the large quantities of water proposed to be pumped."

The engines are horizontal, having cylinders of 24 in. diameter and 3 ft. stroke, with a peculiar arrangement for working expansively—the invention of Mr. Dowell, at present in the employment of Messrs. Robert Napier and Sons. It is extremely simple and complete; the lead, or opening of the valve, at the commencement of the stroke, is constant, or nearly so, and the amount of steam admitted when the piston has travelled equal distances from either end of the cylinder is nearly equal, whilst the amount of expansion can be varied with great ease by merely turning a screw. Mr. Dowell has kiudly supplied the following description:—

DESCRIPTION OF MR. DOWELL'S GEAR FOR OBTAINING VARIABLE EXPANSION WITH EQUAL DISTRIBUTION OF THE STEAM.—"In this arrangement the variable expansion is obtained by operating on the steam slide valve of the engine, so as to vary the travel, the lap, and in this case the lead also, remaining the same for all the different travels. The ordinary single eccentric, with its appendages of catches, gab, and starting bar, is retained, whilst a curved lever is introduced, and the usual eccentric rod reduced to a length of about $2\frac{1}{2}$ times the throw of the eccentric, its end being connected to the lever. The curved part of the lever is constructed with a radius equal to the length of the eccentric rod, and is furnished with the means of traversing the eccentric rod pin to any part of the arc at pleasure, the admission being increased on its approaching the fulcrum, and *vice versâ*. This is effected in the simplest manner, by means of a screw and hand wheel attached near the fulcrum of the lever, and acting on the slide. A pointer is fastened on the screwed rod to indicate the grades of expansion. The motion is transmitted to the valve by attaching the gab rod to any convenient point of the lever, generally about the middle of the arc.

"In Fig. 12, Plate cxxxii., the mechanism is shown in a position to correspond with the crank on the dead point, the piston being about to commence the out-stroke. The valve is shown with the opening for admitting steam sufficiently advanced to give the desired lead. The arc of the lever is constructed, as already mentioned, with a radius equal to the length of the eccentric rod, and in its present position the centre of the eccentric is also the centre of the arc. It will be plain, therefore, that the slide attached to the eccentric rod joint can pass from one end of the arc to the other without disturbing the lever or valve, and consequently with the lead remaining unchauged. Suppose now the crank to have travelled to the other dead point for the commencement of the in-stroke, it will have moved through exactly a semicircle, and will therefore be diametrically opposite to its former position. As the eccentric's motion is similar to the crank's, its new position will likewise be diametrically opposite to its first. Let E, E′ be these two positions. On the line, F O, drawn from the centre of shaft perpendicular to the diameter passing through E E′, place the fulcrum of the lever at such a distance from the shaft as will be presently explained. It may, however, be anywhere on the line, F O, as far as variable expansion is concerned. Suppose it placed for the present at F; then from F, as a centre, describe an arc of a circle, passing through the points, E, E′; then into whatever position the lever moves, the centre of its arc will always be found in this circle; and on the arrival of the eccentric at E′, both the centres will be found exactly at the same point, so that the eccentric-rod can slide from end to end of the arc, as at E, without disturbing the lead.

"It was stated already that the admissions varied as the travels. This, however, is not literally correct, for the lever can be of any length, provided the fulcrum be on the line, O F; and if infinitely long, the travels would be equal for every grade. Correctly, then, the admissions of steam vary as the angles which lines drawn from the centres of the eccentric pins on the lever to the centre, O, make with the radius lines of the eccentric when in the position, E, or E′. These angles may easily be found by the methods usually adopted for setting the valves of ordinary engines with a single eccentric.

"As regards the equal distribution of the steam, this requirement is accomplished by prolonging the lever to a greater length along O F than would give travels proportional to the admissions, as in the ordinary link motion. In consequence of this prolongation, the angle of the eccentric for the in-stroke is increased by a considerable amount, whilst that for the out-stroke is diminished by about the same amount. This variation in the angles of the eccentric is followed by a corresponding modification in the angles moved through by the crank until suppression occurs, amounting to an increase of twice the small angle for the in-stroke, and a diminution of twice the other angle for the out-stroke. This result exactly suits the angles moved through by the crank for the in and out strokes, the former being considerably in excess of the latter for the same positions of piston.

"It may be noticed that the prolongation of the lever to the extent shown in the diagram has no equalising effect on the admission at points in the lever corresponding to admissions of three, two, and one-tenth of stroke, the fulcrum being nearly at right angles to the centre line of motion at $\frac{3}{10}$ths grade. These grades are easily managed by a slight alteration in the lead, being made to increase from $\frac{6}{10}$ths to $\frac{1}{10}$th for the in-stroke, and to diminish from $\frac{6}{10}$ths to $\frac{1}{10}$th in the out-stroke, the change of lead to effect a close enough equality being $\frac{1}{8}$th in. in each case.

"This change is accomplished by having the centre of the lever arc in a circle about $\frac{1}{4}$ in. farther from the fulcrum than the one passing through the points, E, E′. Besides equalising the admission, this variation of lead is useful in equalising the openings, which would otherwise be less for the in than for the out stroke at these points.

"The accompanying Table exhibits the distributions and leads as arranged for the *Islesman*—the points of release and compression being also recorded:—

Points of Suppression; being a mean of both sides in tenths of stroke.	Distribution; giving the distances travelled by piston at supp. for both sides.		Leads.		Release; measured from end of stroke.		Compression; measured from end of stroke.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
6	21	22	$\frac{1}{4}$	$\frac{1}{4}$	$3\frac{1}{8}$	$3\frac{1}{4}$	$5\frac{7}{8}$	$5\frac{7}{8}$
5	$17\frac{1}{8}$	$18\frac{7}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$4\frac{1}{4}$	$4\frac{1}{4}$	$7\frac{1}{4}$	$7\frac{1}{2}$
4	$13\frac{5}{8}$	$15\frac{3}{8}$	$\frac{1}{4}$ full.	$\frac{1}{4}$ bare.	$5\frac{1}{4}$	$5\frac{1}{4}$	$9\frac{1}{8}$	$9\frac{1}{8}$
3	10	$11\frac{7}{8}$	$\frac{5}{16}$	$\frac{3}{16}$	$6\frac{1}{4}$	$6\frac{3}{4}$	11	11
2	$6\frac{3}{4}$	$8\frac{1}{4}$	$\frac{5}{16}$ full.	$\frac{3}{16}$ bare.	$7\frac{7}{8}$	$8\frac{1}{2}$	$13\frac{1}{2}$	$13\frac{1}{8}$
1	$3\frac{3}{4}$	$4\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{8}$	10	11	$16\frac{1}{2}$	16

"The length of the connecting-rod of the engine in this case was four times that of the crank. It is plain that the shorter the connecting-rod is, the more difficult it is to equalise the distribution, as it requires a greater length of lever. For the usual proportions of connecting-rods and cranks in marine engines, a distance from centre to fulcrum of about twice the length of the eccentric-rod will be found to give distributions practically correct. In the *Islesman* it was 1·9 times, but it would have given a better distribution if made twice the length, which, however, could not be conveniently accomplished in the arrangement. In oscillating engines, for which the scheme is extremely well adapted, and in other vertical engines, it is not desirable to arrange the distributions perfectly equal; a sufficient excess of admission is usually given to the lower side of the piston, to cause the difference of mean pressure in favour of the lower side to be exactly equal to the unbalanced weight of the piston, rod, &c.; but in horizontal engines, and more especially in

those intended for high speeds, there is nothing conduces more to their perfect action than having the distributions as equal as possible."

The engine is connected to the propeller by a wheel and pinion, so as to multiply its revolutions. As regards giving the propeller the same speed as, or a higher speed than, that of the engine, I am aware there are great differences of opinion, but as I believed that the most efficient vessels were those with short-pitched propellers, of such a diameter as not to churn the water, from the upper portion being too near the surface, the company were advised to adopt the wheel and pinion. The diameter of the propeller is 6 ft., and the pitch 6·5 ft.; and when the engine makes seventy revolutions per minute, it makes 172·3.

The windlass may be noticed as a revival of an old form, and I am sure it will be admitted by those conversant with the patent articles usually supplied to ships for raising and lowering their anchors, that a mechanic might turn his attention to the subject with great hope of making a more efficient machine. The *Islesman's* is submitted as simple and efficient. The chain-barrel is small, and the wheel large. The motion regular. The space it occupies is small, and by means of the friction-break the anchor can be lowered at any velocity the captain pleases. There is a pall on the large wheel, and the chain-stopper is a flap or valve on the inside of the hawse-pipe.

I have already mentioned that the vessel was divided into seven watertight compartments, and supplied with a pump capable of discharging at least 300 cubic ft. of water per minute. Notwithstanding the great safety of such arrangements, the Fishery Company were obliged to have the after part plated over and made watertight, and two of the wells or tanks shut up, ere the surveyors of the Board of Trade would grant a licence to carry passengers.

ON WINDING APPARATUS, INCLUDING MINING HOISTS.

By Mr. James Robertson.

(Illustrated by Plate cxxxii.)

[ABSTRACT.]

The object of this Paper is to describe a system of hoisting machines, the leading feature of which consists in the introduction of wedge-surface frictional wheels for connecting the winding barrels or drums with the actuating power, instead of the cog wheels ordinarily employed.

From the peculiarity of these wheels as regards the mode in which they act on each other, the forms of ordinary hoisting machines, for many situations, require to be considerably modified to secure their proper action; and it is in their various modifications, joined with the general facilities they afford for simplicity of construction and their safe and effective action, that their claim to attention mainly consists.

The more prominent advantages attending this system of wheel-gearing as applied to hoists are—its non-liability to fracture, its smooth unbroken action, and its ready facilities for reversing, breaking, engaging, or disengaging, without the intervention of clutches or other appliances hitherto in use for these purposes.

In working, all hoisting machines are liable to sudden jerks or strains, arising from various causes, such as the uneven winding of the chain or rope on the winding-barrel, and partial unwinding—caused by its re-adjusting itself; extension of the slings immediately connected to the weight, sudden entanglement, over-winding, and other accidents, which frequently occur, even in careful hands—causing the body in motion to become suddenly at rest, or to acquire a motion backwards, whilst the winding of the chain continues; thus allowing the load and machine to acquire momentum in opposite directions, and changing the nature of the effect on the machine and lifting chains from a steady tension to an effect approaching percussion.

To meet these irregularities, considerable allowance of strength is usually given in constructing hoisting machines, beyond what is necessary for fair action; but in many cases, especially in high-speed power hoists, the irregularities are such that no practicable extra allowance of strength will give safety in all contingencies, as the jerk or concussion at times becomes so great that something must necessarily give way, where all the connecting gear is of a rigid, unyielding nature.

It is chiefly to power-hoists that the improved system has been and is being applied. In large size and high-speed hoisting machines, such as pit winding engines, it is chiefly the non-liability of the wedge-surface frictional wheels to fracture, and their smooth action, which are of most advantage. In small hoists and steam-cranes this quality is also an advantage; but the facilities for reversing, breaking, engaging, and disengaging, together with the motions peculiar to this system, are of more advantage, as they simplify and render these machines more manageable generally—cheapening and presenting inducements for their more extended use.

A simple and useful arrangement consists of a winding-barrel, driven by a grooved wheel keyed on the barrel spindle. The shaft carrying the pinion may be connected to be driven continuously by any power. Motion is communicated to the barrel by drawing the wheels into contact, which can be done very simply in many ways. A small separation of the grooves (grooved surfaces) serves to throw the wheels out of gear; and when out of gear, the barrel being unconnected with any retarding cause beyond the friction of its bearings, is free to unwind by hand or by the weight. Under various forms this simple arrangement has been applied to sack-lifts and other similar lifting apparatus; their arrangement varying with the situation in which they are placed, and with the connecting gear by which they are driven.

In a modification of this movement, having a breaking arrangement, the driving pinion revolves continuously, and the beam on which the barrel bearing rests nearest the wheels is hinged at one end, and is moved up and down at the other extremity by a small eccentric with a handle. When the beam is lowered, the weight of the barrel and wheel holds the wheel effectively in contact; and when the lifting-rope descends in the line of the centres, the weight of the load also tends to hold the wheels in gear. When the handle is lifted upwards, the wheel is lifted up out of gear from the pinion, and is brought into contact with a grooved concave stationary break, fixed on the side opposite to the pinion, so that the connecting and breaking actions are managed by one handle.

In a third modification, an internal reversing wheel is used, which, on changing the grooved pinion from the inner to the outer rim, gives reverse motion, suspending its action when held in a central position. The backward motion works at a higher speed than the lifting one.

In a fourth modification, a bevil-wheel reversing movement is applied to a hoist—the pinion, when revolving continuously in one direction, communicating a reverse movement to the hoist, when it is drawn from the one wheel to the other. When it is held in a central position it is out of gear, and the barrel is free to unwind by hand. Self-acting break movements are easily connected to both these last modifications, so as either to hold the winding barrel stationary when the pinion is in a central position, or allow a weight suspended to descend gradually.

Various modes of working grooved-surface concave, convex, and disc breaks are employed, and arrangements for rendering their action simultaneous with the disconnecting or reversing of the barrel motion. This form of break is much more powerful under the same pressure than smooth-surface breaks, and one of its principal advantages is the ease with which the amount of retarding action can be moderated; this arising from the wedge action requiring a greater amount of traverse between tight and loose positions than is experienced with smooth surfaces.

In a simple modification of grooved-wheel winch or hoist, driven by a belt, the pulley spindle has keyed upon it a grooved pinion, and revolves continuously with the pulley. The chain barrel has keyed on it at one end a wedge-surface wheel gearing with the pinion on the pulley spindle, and on the other end an internal break rim. The barrel revolves loosely on its spindle, and the spindle is supported in its position by eccentric snugs formed on each of its ends, which rest in the cheeks. On one end the snug is extended beyond the cheek, and a handle fixed on it. By moving the handles backwards or forwards, the spindle is partially turned round, and in consequence of the eccentricity of the snugs, this motion gives the barrel a small amount of lateral traverse, in consequence of which, when the handle is brought into a forward position, the wheels are in gear and the barrel in motion; whilst on the handle being drawn backwards, the internal break rim is brought into contact with the segmental breakpiece fitted on the cheek; and finally, when the handle is held in a central position, the barrel is free to unwind. This kind of hoist can be variously formed, so as to be suited for fixing either on a floor, wall, or ceiling.

Fig. 13, Plate cxxxii., is a front elevation, and Fig. 14 is an end elevation of a steam winch, worked by one steam cylinder, the crank shaft being made to revolve continuously in one direction, whilst the motion of the barrel is reversed by means of an internal reversing wheel of the kind already described. The frame of the winch is constructed of the usual form, with two cheeks, A, connected together by stay-rods, B, the barrel gearing working between the cheeks. A small frictional pinion, C, is keyed on the crank shaft, D, which acts on the internal or external rims, E, F, of the reversing wheel, and gives reverse motions, the power being further reduced at the winding barrel, G, by a grooved pinion, H, and wheel, I. The pinion, H, is keyed on the spindle, J, of the reversing wheel, E F, the wheel, I, being keyed on the winding barrel, G. The outer rim of the reversing wheel is grooved externally, to form a break wheel, and is acted upon by a concave segmental break, K. The changing of the pinion, C, to different rims, E F, of the reversing wheel, to suspend or produce motion in either direction, is provided for by passing the end of the crank shaft, D, nearest the grooved pinion, through an eccentric bush L, on turning which bush partially round a slight lateral shift is given to the pinion. The adhesion is maintained on either side by a small balance weight, M, keyed on the bush, L, and when the weight and its connecting lever is in a vertical position, the pinion, C, is out of gear, and when the weight, M, is turned to either side, the pinion, C, is brought into contact with the reversing wheel, E F. For regulating the motion of the winch, a handle, N, extends conveniently outwards from it for the hand, and this handle, N, is keyed on a spindle, O, which passes through the cheeks, A, and along the entire length of the winch, and having upon it in appro-

priate positions various levers for working the break, reversing movement, aud steam valve, and so arranged that when the handle, N, is held in a central position, the break is applied, the pinion, C, out of gear, and the steam shut off. When the handle, N, is moved forwards, the break is disengaged, the pinion, C, thrown into gear for lifting, and steam to the amount required at the same time admitted for lifting. When the handle, N, is drawn backwards, a corresponding action at double the lifting speed is obtained for lowering, and at a less distance back for lowering a weight by the break, without the steam. To prevent the engine sticking on the crank centre, a small jet of steam can be admitted to keep the crank shaft constantly in slow motion. All the movements of the winch are managed by one handle, and without any jarring action.

Whilst this frictional system applies with much advantage to small hoists and cranes—simplifying and making them more manageable—for heavier operations, such as pit-winding engines, the writer would urge its advantage more pressingly. In the latter, greater interests are concerned, and from the liability to accident to which the machinery now employed in this branch of industry is exposed, any contrivance offering with reasonable likelihood to lessen this liability, at least deserves attention. In a good example of the application of the improved gearing to a double-cylinder pit-winding engine, with winding gear complete, the cylinder, valve gear, both ends of the crank shaft, and also one end of the pirn shaft, are supported on a pair of triangular cheeks, firmly stayed and bolted together by means of hollow cast-iron stays, made in the form of common flange pipes. The inner pedestal of the pirn-shaft rests in the cheek adjoining the pirn, and directly below the centre of the crank-shaft, so that the driving pinion, together with the crank shaft and small fly-wheel, rest with their entire weight on the driven wheel, keyed on the pirn shaft to give the required adhesion. But, incidentally with this design, a firm and compact winding-engine is obtained without any necessity for a sole plate, and requiring no greater amount of material than, if so much as, the common winding-engine, to give the requisite strength. The connecting rods of both cylinders are coupled on one crank, and the slides and other parts are of simple arrangement and of easy access. The valves are worked by link valve motions, so arranged that the weight of the link and rods of one engine balances that of the other, without the intervention of balance weights. The winding-shaft extends out in the same vertical plane as the engine shaft, and its outmost bearing is supported on a casting set on the same level as the engine, so that there is little building required for a foundation. A break is hinged on the cheek, and acts on the grooved wheel on the pirn shaft, being pressed on it when required by a foot lever which acts by a small eccentric on the break piece. A small shaft is carried in, and extends between the cheeks of the engine, carrying on it two levers for working the valve motions, and a handing bar for regulating the engine, the link gear giving easy control, whilst, at the same point, are also conveniently placed the foot break and steam valve levers. Steam is admitted by a steam-valve at each casing, connected by a rod extending between the casings, so as to make their action simultaneous.

To insure the certainty of continuous adhesion, the brasses of the crank shaft next the pinion are set in a guide pillow block, somewhat similar to a railway-carriage or locomotive axle box; so that the brasses are at liberty to slide down free of any obstruction except the wheel. No perceptible wear takes place in the wedge-surface frictional wheels, so that the position of the gearing will not change; but this arrangement of pillow-block is adopted to insure the continuance of the adhesion, aud as the journal is both secured by a cover and free to gravitate to the wheel by its own weight, the contact can never fail.

Supposing the joint effect of the coupled engines to be equal to 24 H.P. when working at 85 revolutions of the crank shaft per minute, and that the pinion on the crank shaft is $2\frac{1}{2}$ ft, in diameter, the wheel 7 ft. in diameter, and the pirn $3\frac{1}{2}$ ft. in diameter, then the circumferential motion of the pinion will be 667 ft. per minute, requiring a pressure of 7 cwt. to give sufficient adhesion for that motion and for the power transmitted. As the adhesion is one and a half times the pressure, the force transmitted to the wheel at its periphery is equal to $10\frac{1}{2}$ cwt., which is the standard dynamical effect of the engine. The pirn being one-half the diameter of the wheel, and the motion being reduced to the same extent, the effect or pull at the rope is equal to 21 cwt. The pressure exerted, however, actually in this case on the wedge surfaces, by the weight of the end of the crank shaft with the pinion and small fly-wheel, is equal to 28 cwt., which is four times more than is required for the power of the engine, and it will take a lift of 4 tons 5 cwt. before the wheels will slip. There is, therefore, provision for certain action considerably beyond the power of the engines under all circumstances. Yet, should the cage get jammed in the guides, or should it overwind, or should any other disturbing cause occur whilst the engine is in full motion, the wheels will rather slip than allow the momentum of the engine to break the rope, and so bring the engine to rest gradually. There is, at the same time, no jolting action with these wheels like that experienced with toothed gear, and fracture is scarcely possible.

A contrivance to prevent overwinding is also connected with this engine, and consists of a shaft parallel to the winding shaft, extending the entire length of the engine and pirn shafts, and passing through and resting in the cheeks and outer end pirn soleplate. It has keyed on it arms or cams, which extend under the pirns, and are set to the exact height which the rope winds when the cage is at the mouth of the shaft. The ropes have on the back of them a piece of rope about an inch thick; and when the rope begins to wind beyond the proper height, it is built upon the pirns higher than usual, and draws in the thickened piece, pressing down the cams on the cross shaft. Opposite the steam valve, and opposite the break, there are arms or levers keyed, which on either of the pirn cams being pressed down, simultaneously shut off the steam, and press up the break so as to stop the engine suddenly, and prevent the cages from reaching the pithead pulleys.

Mr. ROBERTSON mentioned that about thirty hoists had been made altogether of one or other of the kinds represented in the drawings exhibited. One of the pit-winding engines was being executed, but it was not yet at work. Some of the hoists made, perhaps half of them, had been fifteen months in use. Eight steam winches of the kind represented in Figs. 1 and 2, Plate ix., had been made. The frictional wedge-surface gearing had been introduced in Lancashire to a greater extent than in the Glasgow district.

In reply to an inquiry by the President, Mr. ROBERTSON said that the adhesion of the surface was found to be about one and a half times the pressure holding the wheels together. The angle of 40° was adopted in the grooves in ordinary cases. For a slow motion, and to transmit a great strain, an acuter angle, such as one of 30°, might be used. The grooves had at first been made with an angle of 50°; but so far, the angle of 40° had been found the best in practice.

In reply to inquiries from various gentlemen, Mr. ROBERTSON stated, that the largest size of wheel yet made on the wedge-surface system was $13\frac{1}{2}$ ft. in diameter; and 24 H.P. was the greatest that the wheels had yet been made for. He would be glad to make heavier and larger machinery on his system, if he could get orders for them, for he found that the larger the apparatus the better was the action. They had now, after considerable labour and experience, arrived at a proper way of constructiug the gearing, and could confidently state that the gearing would run for years without being worn. Some wheels had been running for six, nine, and even nineteen months, and the marks of the turning tool were even perceptible in the grooves. Usually the grooves were turned with $\frac{1}{2}$ in. pitch. At first, a great deal of trouble was experienced with minor details. The speed rings had not been found to answer where driven by a long "swaggering" belt, but with a short belt they acted quite well.

In reply to inquiries from Mr. Napier, Mr. ROBERTSON stated that the frictional gearing had been applied to a screw popeller in one instance—namely, in a boat built by Messrs. Tulloch and Denny, of Dumbarton. Several trial trips had taken place, and the wheels had answered every expectation; the boat, however, was a yacht, and being completed late last autumn, was laid up during the winter. One of the most important applications of the system was that to screw propellers. There could not be a doubt that it was the best thing for geared screw-propeller engines. In the case referred to, the pinion was fitted with three feathers upon the propeller shaft, in a pretty tight manner, but so that the thrust sustained by the shaft would not affect the pinion. Sufficient pressure was obtained between the pinion and driving-wheel, by means of springs applied to the bearings of the shafts. The wedge-surface system had been applied, in one instance, in the construction of a ship's windlass. In this case a peculiar arrangemeut was adopted: a wedge-surface chock, fitted with a long lever, was applied between concentric external and internal wedge-surfaces, in such a way that on lifting the lever the chock slipped round, but took a firmer hold, and turned the windlass on the lever being brought down.

In reply to an inquiry from Mr. More, Mr. ROBERTSON said he had made careful experiments to ascertain the frictiou on the brasses, having tested it by means of weights. He had found that the surfaces would transmit a strain equal to one-and-a-half times the pressure on the shafts, without the slightest chance of slippiug. The cleaner the surfaces were, the better they held; the actual adhesion seemed, in practice, to be greater thau what might be expected from Morin's well-known experiments on friction, and it had been suggested that a kind of metallic cohesion came into play.

In reply to an inquiry from the Presideut as to the effect of grease or water upon the surfaces, Mr. ROBERTSON said, that with small sizes the surfaces must be carefully kept free from grease, but with large sizes it was not so important. He had had complaints as to the working of some wheels, and on inquiry found that oil had been poured on them. On the surfaces being freed from the oil, the wheels worked perfectly well. When the wheels were upwards of 2 ft. in diameter, grease did not affect the working so much. He had not found water to make any difference; it might increase the adhesion, but, so far as ascertained, it did not diminish it.

40 r 6

ON EMPLOYING STEAM EXPANSIVELY.

By Mr. Alexander Morton.
(Illustrated by Woodcuts.)

The economy of fuel obtained by the expansion of high-pressure steam, has been the subject of much discussion and experiment amongst engineers; although many have still doubts on the subject, and we hear of many failures, yet there are successful trials, which sufficiently prove that economy really does result from expansion, if the proper means are employed. It is well known that, in most cases, success has been owing to the steam being supplied with additional heat whilst expanding. When steam or air is compressed, a certain degree of heat is made sensible, which disappears on its being again expanded Gay Lussac says, if air be compressed into one-fifth its original volume, it will ignite tinder, but he does not state at what speed the compression takes place. Those workmen who daily use the fire-syringe can produce fire when the air is far less compressed, and if the speed of compression could be sufficiently increased, air might ignite tinder when very slightly compressed. It would be unreasonable to believe that the amount or degree of heat made sensible by compression could cause re-expansion, so as to raise the weight by which it was compressed, at a greater velocity than that of compression, without being supplied with additional heat from surrounding bodies. It is a universal law that force, whether in the form of heat or anything else, cannot be gained or created; therefore the amount of heat made sensible by compressing air or any elastic fluid cannot expand it at a greater velocity than that at which it was compressed, without abstracting additional heat from surrounding bodies. The amount of heat required to expand saturated steam depends wholly upon the speed of expansion; and on examining indicator figures taken from engines working expansively, it will be found that the speed of the piston distinctly alters the curve. If a given volume of air in contact with a given volume of water of an equal temperature is very slowly expanded, the temperature will very slightly diminish; but when it is expanded at a great velocity, the temperature will be greatly reduced, and as the speed of expansion is increased, a proportionally greater diminution of temperature is indicated by the thermometer immersed in the water. When a piece of copper wire is drawn through a die less than itself, being thereby lengthened, if it is wholly immersed in a given quantity of water, the rise in temperature will correspond to the speed with which the wire is drawn. If a fly-wheel running at a given velocity be immersed in water, the motion gradually diminishes, and the water rises in temperature; but if the wheel be held against the side of the dish containing the water, a greater rise in temperature will be indicated. If the total heat in a given weight of steam is measured by suddenly mixing and condensing it in a given quantity of water of the temperature of 40° Fahr., 1040° becomes sensible; but if the steam is slowly condensed in a small surface condenser, 680° only may become sensible. Experiments which I have performed, giving these and many similar results, prove that the amount of heat made sensible depends upon the speed with which equilibrium is destroyed or restored. The latent heat in steam can be viewed as a motion of its matter, and the heat made sensible in restoring equilibrium depends wholly upon the period of time in which it is restored. Time, heat, and motion, may therefore be intimately connected.

Fig. 1.

Fig. 1 is a representation of a column of high-pressure steam issuing freely into the atmosphere. If the hand be held at the base of the column, a great degree of cold is felt in the surrounding air immediately in contact; and the greater the pressure of the steam before liberation, the greater will be the degree of cold felt. If a spring balance (having a very light disc attached) be held in the issuing column, an oscillatory motion will be imparted to the disc, the time of an oscillation depending upon the pressure or on the speed of expansion. As we ascend the column, the time of an oscillation is greater; and asthe pressure of the steam is increased, the temperature of the issuing steam near the base of the column diminishes, as shown by inserting a thermometer. The steam on being liberated suddenly expands, and the surrounding air endeavours to supply the demand for heat; but as the heat in the air is unable to supply the expanding steam with sufficient rapidity, the steam partially condenses, and the heat produced by this partial condensation maintains the remaining steam, which causes the volume to alternately increase and decrease, producing the oscillations shown in the figure. To trace this phenomenon still further, I experimented with a small high-pressure engine, driven at different speeds, with the view of determining the speed best suited for different pressures, with different degrees of expansion. In experimenting at slow velocities, no condensation of the steam in the cylinder was perceptible, and the figure traced by the pencil of the indicator showed a regular curve, represented in Fig. 2. When the velocity was increased, the figures became oscillatory, and a greater condensation of the steam in the cylinder was very evident on opening the discharge cock. As the speed was further increased, the oscillation and condensation rapidly increased, and the indicator figures became no guide for the quantity of steam used, but the greater amount of fuel required distinctly proved that the steam was not sufficiently supplied with heat for the rapidity of its expansion. On examining figures taken from engines working expansively, it will be seen that the speed of the piston has a great effect in changing the form of the curve. When the piston is at its point of greatest speed, the pressure falls quickly, and as the speed of the piston diminishes towards the end of its stroke, the figure falls less and less quickly. The influence of the same law is shown on compressing steam into a less volume; the greater the speed of compression, the greater is the rise in pressure. Locomotive and other engines working expansively, by means of the link motion,

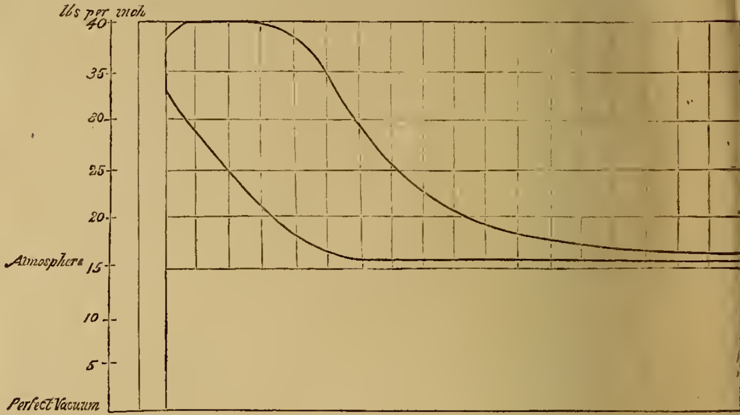


Fig. 2.

compress a certain volume of the exhaust steam at the termination of each stroke; and on measuring any of the figures of such engines, it will be seen that the greater the speed of compression, the higher the pressure of the compressed steam. An example of this is given in Fig. 4. When steam of a certain pressure is suddenly exhausted into the atmosphere, or into the condenser, the sudden expansion of the steam robs the cylinder of a great portion of heat, and by altering the speed of exhaust, the condensation of the entering steam can be increased or diminished. Short-stroked engines running at a high speed open the exhaust with a greater speed in proportion, consequently a greater amount of heat is robbed from the cylinder. It is a great mistake to construct an engine with a sudden exhaust and a large condenser. The Cornish pumping engines have very small condensers, and very slow exhausts, which gives them an important advantage over the generality of short-stroked crank engines. If the exhaust steam could be removed

Fig. 4.

from the cylinder before being expanded, then our only loss would be the pressure of the steam at that period. In Cornwall the steam induction passages are virtually the largest, and the eduction the smallest, quite contrary to the general practice elsewhere.

The jacket in these engines supplies heat to the cylinder, and the steam maintains nearly a uniform temperature throughout the stroke, and instead of throwing the whole of this valuable heat into the condenser, a certain portion of it is retained, and compressed in cushioning the moving mass at the termination of the out-door stroke. This portion of super-heated steam filling the clearance space above the piston, superheats the entering saturated steam, admitted suddenly by the sudden opening of the large steam-valve; and this heat maintains the steam in its gaseous form without extra fuel, since it is recovered from the previous-stroke steam. (*To be continued.*)

INSTITUTION OF CIVIL ENGINEERS.

May 18th, 1858.

Joseph Locke, Esq., M.P., President, in the Chair.

The first Paper read was On the Construction of the Southampton Docks. By Mr. Alfred Giles, M. Inst. C.E.

The Author stated that these docks were designed by the late Mr. Francis Giles. The works were commenced in the autumn of 1838, by building a quay wall from the shore towards low water, and by driving piles for a cofferdam, for the enclosure of the dock. These works were stopped during a financial difficulty, after an expenditure of about £7,000. They were resumed in 1840, but an alteration was made in the mode of procedure, in order to obtain a quay berth for the vessels then building for the Royal Mail Steam Packet Company. It was, therefore, proposed to build the quay walls in short lengths upon piles, and afterwards to dredge the dock to the requisite depth. Subsequently, owing to an increase in the size of the vessels, and to a delay in their completion, it was considered desirable to enclose the whole area, so that the dock might be excavated to one uniform depth, and the foundations of the walls be carried to the bottom. For this purpose, an embankment was thrown up by tide work, enclosing about 20 acres, the soil excavated from the enclosure being used to form the embankment. Some difficulty was experienced at the point of junction of the embankments with the coffer-dams, which were 2,170 ft. in length. In November of the same year, during the occurrence of a violent gale, a breach was made in the bank itself; but this it was not thought necessary to repair, as the enclosure was nearly complete, and indeed was perfected in the following March. The excavation of the dock was then proceeded with, and the quantity of soil so removed amounted to 1,150,000 cubic yards, the contract price for which was fourteen pence per yard. During the progress of the excavation, the foundations and masonry of the walls were carried on as rapidly as possible; but the walls had not been advanced to their full height when several heavy slips of earth caused some portions to move forward. The piles were consequently strengthened; but as the walls still moved forward, additional engineering advice was obtained, and a plan for land-tying the walls was suggested and carried out. This plan consisted in drilling holes through the walls as low as the tide would allow, inserting strong bars therein, and tying them back to heavy buttresses of piles, driven at a distance of upwards of 100 ft. from the wall. After an expenditure of about £10,000, this plan proved a failure, when further mischief was prevented by the removal of the soil from the back of the walls. The walls were strong enough in themselves, but the evil lay in the foundations. One wall, in a length of 600 ft., was found to have moved forward 3 ft.; whilst another, only 650 ft. in length, had two distinct bulges of 2 ft. 3 in. and 2 ft. 6 in. beyond the straight line. These walls were 38 ft. in height from the coping to the foundations; they were built on a timber platform 6 in. in thickness, the front of which rested on piles driven to the batter of the wall, while the back rested on longitudinal sleepers laid on the soil. Up to low-water mark they were built with brickwork and concrete bays, and above of rubble masonry, faced with granite ashlar, and having a granite coping. The cost of the wall was £40 per lineal yard. This dock, having an area of 16 acres, with quay 3,300 ft. in length, an entrance 150 ft. in width, and a depth of 18 ft. below the average of low water of spring tides, was opened in June, 1842.

Owing to the method of founding the walls, an unequal settlement took place, which produced a longitudinal crack. The pressure of the back-water against the dislocated face, assisted by the outward thrust of the shears, which were set on the edge of the quays, and by a severe frost operating upon the water in the crack, caused a length of 124 ft. to separate; the shears fell, and were destroyed with the wall, and an additional length of 120 ft. was so damaged that it was necessary to rebuild it. The square counterforts were torn asunder at the line of the back of the wall, so that the Author subsequently adopted a different form, being a square joined to the back of the wall by its diagonal, which he conceived to be the most suited to resist the strains to which it was liable. The fall of the wall occurred in January, 1854, and its rebuilding cost £11,500, and occupied twelve months. The coffer-dam used in the reconstruction had to sustain a pressure of 33 ft. of water. It was made of two rows of piles, 6 ft. 6 in. apart, without any gauge piles. The cost was £20 per lineal foot.

In 1846, the first graving dock was constructed of stone, at a cost of £49,800. The length of the floor was 282 ft., the breadth of the gates 66 ft., and the depth over the sill at high-water spring tides 18 ft. It was lengthened to 343 ft. in 1852, at an additional cost of £1,800.

In 1847, the second graving dock was executed, at a cost of £19,290. The length of the floor was 250 ft., the breadth of the gates 51 ft., and the depth over the sill at high-water spring tides 14 ft. This dock was built of brickwork and concrete, having only the nosings of the alters, and the key of the invert, of stone. It was particularly free from leakage, and the cost was small.

In 1851, it was determined to complete the excavation of the area which had been partially cleared in 1840, and to build walls on two sides. This work was executed in the summer of that year, at a cost of £18,000. The area of the dock was 10 acres, its depth of water was 25 ft., the length of the walls was 1,800 ft., and the entrance of the lock was 46 ft. in width. The quay walls were made of concrete, with a rubble face, built of Purbeck stone, tied to the concrete by transverse layers of iron-hoop bond. The concrete was made of blue lias lime and gravel, in the proportions of 1 to 8, the gravel being obtained from the excavations. The cost of the wall, 35 ft. in height, from the coping to the foundations, was £19 10s. per lineal yard. These walls had answered exceedingly well; their great bulk afforded security against backward pressure, and the width of the base tended to prevent unequal settlement; and for economy they would bear favourable comparison with any other walls. There was only one pair of gates to this dock, as the neck of the entrance was too short to admit of a lock of adequate length for ordinary screw steamers. As high-water remained nearly stationary at Southampton for from two to four hours, the gates were allowed to remain open for the ingress and egress of vessels for at least three hours out of every twelve hours. The lock gates were made of oak posts, with fir bars and planking, and from being framed during the summer, they became so light as to require loading when hung. The bridge across the entrance was framed in two leaves running on wheels, the overhanging parts of each leaf being balanced by the length on the wheels. It was opened by each leaf being run backwards, under a vertebrated and self-supporting platform, which was raised by the bridge itself. It was used for carriages and railway trucks, and had raised footways on each side.

In 1853 the increasing size of the ocean steamers induced the Directors to authorise the construction of a graving dock, having a length of floor of 425 ft., gates 80 ft. in width, and a depth of 25 ft. over the sill. This work was completed in December, 1854, at a cost of £53,000, inclusive of the coffer-dam necessary for making the entrance. The foundations were laid on concrete, 4 ft. 6 in. in thickness, upon which was built a base of brickwork and tiles in cement to receive the brick invert, having simply a stone key, and stone noses and seats for the alters. This large dock could be emptied in less than three hours, and, in cases of emergency, docking and undocking had been repeated twice in the twenty-four hours. The gates were constructed of wrought-iron beams, with oak heel and mitre posts. They were worked by ordinary winches, and could be opened in six minutes by four men on each side. For graving dock purposes, where leakage was objectionable, the Author thought gates entirely of wood were preferable, as iron, being acted upon by changes of temperature, the gates were liable to become leaky at the mitre posts.

When the first dock was opened in 1842, the tonnage of vessels entering and leaving the port of Southampton was 276,000, whilst in 1857 it was 657,000. The appliances now existing consisted, first, of an open dock, which all ordinary vessels could enter, at all times of the tide, with quays 3,000 ft. in length; second, of an inner dock, which large vessels could enter, or leave, for nearly six hours out of every twenty-four hours; third, of graving docks, which could accommodate the largest class of vessels, with shears capable of lifting weights of 50 tons; and fourth, of a system of railways running all round the quays, in connection with sheds and warehouses for the examination and deposit of goods, and for direct transmission to all parts of England, without change of carriage. The entrance to the inner dock was about to be widened, and both the entrance and the dock itself to be deepened, whilst the walls were to be continued round the south and west sides, with a view to the construction of another dock on the western side.

The expenditure on the docks, dry docks, custom-house, sugar refinery, workshops, warehouses, sheds, rails, and all other appliances, up to the present time, had been £705,000. The gross return was £53,000 per annum, and, although the dividend to the original shareholders had not hitherto exceeded 4 per cent., the country had been benefited by the conversion of a huge mud bank into a useful national work.

The second Paper read was Description of Works recently Executed for the Water Supply of Bombay, in the East Indies. By Mr. H. Conybeare, M. Inst. C.E.

It was stated that the water supply of Bombay had always been as deficient in quantity as it was bad in quality; and as the population rapidly increased from 254,000 in 1833, to 556,000 in 1850, and 670,000 in 1855, the frequent water famines occasioned serious alarm. Already, in seasons of scarcity, water was imported into Bombay, in boats and steamers, from the Island of Elephanta, and the resources of the Great Indian Peninsula Railway were taxed to the utmost in bringing in a still greater quantity from Salsette. The population was mainly dependent for water, during nine months out of the twelve, on the rain caught during the monsoon in old quarries and other shallow excavations, which became thoroughly contaminated as the dry season advanced.

The first project for increasing the supply was due to Colonel Sykes, late Chairman of the East India Company. He proposed, nearly thirty years ago, to collect and impound the rain water falling on the high ground at the south-western extremity of the Island of Bombay. This plan was revived by Colonel Jervis in 1845. Another proposed plan was that made by the late Mr. Rivett, who suggested that water should be collected and stored in the high grounds of the adjacent Island of Trombay. In 1846, Major Crawford pointed out the capabilities of the valley of the Goper, in the adjoining island of Salsette. The central plateau of Salsette, which is drained by the Goper and its affluents, is bounded and intersected by ranges of hills, amongst which favourable sites for the storage of water could be obtained. This plan lay dormant, with the others, until the water famine of 1851, when Lieut. De Lisle was instructed to make a preliminary survey of the valley. Soon after, the question was referred to the Author, and the conclusion was arrived at, that the valley of the Goper was the only possible source whence an adequate supply could be procured.

The course recommended by the Author having been adopted, he was selected to carry out the works. It was then ascertained that the high ground in which the Goper took its rise afforded five sites for storage reservoirs, two of which, the basins of Vehar and of Poway, were as large as lakes. As an investigation showed that the Vehar basin was adequate to the collection and storage of all the water that could be required for some years, the works were confined, in the first instance, to the construction of this single artificial lake. It was considered that the rainfall available to the supply of the reservoirs might be safely assumed at six-tenths of the total quantity (124 in.), or 74·4 in. over the area of the gathering grounds. At this rate, the supply available from 3,948 acres (the area draining into the Vehar basin, above the site of the impounding dams), would be 6,664,834,787 gallons; and that available from 5,500 acres, to which the area could be enlarged, about nine thousand million gallons. When filled up to the level of the waste weir, the maximum depth of the Vehar lake was 80 ft. It covered an area of 1,394 acres, and stood 180 ft. above the general level of Bombay. The water in the lake was impounded by three

dams, one of which contained nearly 300,000 cubic yards of earthwork and puddle. These embankments were formed in regular layers, not more than 6 in. in thickness, each properly watered, punned, and consolidated. The puddle wall was 10 ft. wide at the top, with a batter of 1 in 8; and the excavation for the foundations was carried down to the solid basalt, past all surface springs. The slopes and surfaces of all the embankments were covered with stone pitching, to protect them from the heavy down-pour to which the hill districts of India were subject during the rainy season. The waste weir was 358 ft. in length, and had a horizontal top width of 20 ft. It was faced throughout with chisel-dressed ashlar, set in cement. The water was drawn from the reservoir through a tower, provided with four inlets, fixed at intervals, vertically, of 16 ft. apart. These inlets were 41 in. in diameter, and were provided with conical plug-seats, faced with gun-metal. The three not in use were kept close by conical plugs, suspended from the balcony above, and were raised or lowered by crane work. The inlet in use was surmounted by a wrought-iron straining cage, covered with copper wire gauze, and fixed to a conical ring fitting into the inlet orifice. This strainer presented a surface of 54 sq. ft. The gauge was capable of being changed from a boat, when clogged, in ten minutes after the cage was drawn up to the surface; or a plug might be substituted for the cage, and lowered to its place in the same time. A similar straining cage, but with 90 sq. ft. of surface, was fixed at the bottom of the inlet well, exactly over the orifice of the supply main. The water thus passed through two strainers before it started for Bombay. By this arrangement, the additional head of water due to the depth of the lake was obtained, which would have been lost had the water been strained, as in the more usual arrangement, at the outside foot of the dam. The supply main traversing the dam was 41 in. interior diameter, and the metal was $1\frac{3}{4}$ in. in thickness. At the sluice-house, situated at the outside foot of the dam, this main bifurcated into two mains, each 32 in. in diameter; but in the first instance only one had been laid, as that was sufficient for the present requirements of Bombay. The length of this pipe was upwards of $13\frac{3}{4}$ miles, the latter 7 miles being carried alongside the Great Indian Peninsular Railway. The only peculiarity in the distribution was the large proportion of the population supplied gratuitously by means of self-closing public conduits.

The contracts for the reservoir works in Salsette, and for all the pipe-laying, were let to Messrs. Bray and Champeney, of Leeds. The pipe contracts were executed by Messrs. D. G. Stewart and Co., of Glasgow. The larger sizes of sluice valves, the hydrants, &c., were manufactured by Messrs. Simpson, of the Belgrave Iron Works. The execution of the works had been carried on under the personal superintendence of Mr. H. Walker, the Resident Engineer, in a most satisfactory manner.

ROYAL INSTITUTION OF GREAT BRITAIN.

April 30, 1858.

His Grace the Duke of Northumberland, K.G., F.R.S., President, in the Chair.

Professor Andrew C. Ramsay, F.R.S.

ON THE GEOLOGICAL CAUSES THAT HAVE INFLUENCED THE SCENERY OF CANADA AND THE NORTH-EASTERN PROVINCES OF THE UNITED STATES.

It is impossible thoroughly to explain all the points of this discourse without the aid of the pictorial illustrations and sections employed on the occasion, and therefore in this abstract only some of the leading geological features are noticed.

The island of Belleisle and the Laurentine chain of mountains, between the shores of Labrador and Lake Superior, consist of gneissic rocks older than the Huronian formation of Sir Wm. Logan. This gneiss is probably the equivalent of the oldest gneiss of the Scandinavian chain, and of the north-west of Scotland, underlying that conglomerate, which, according to Sir Roderick Murchison, in Scotland represents the Cambrian strata of the Longmynd and of Wales. The mountains of the Laurentine chain present those rounded contours that evince great glacial abration; and among the forests north of the Ottawa, the mammillated surfaces were observed by the speaker to be often grooved and striated, the striations running from north to south. The whole country has been moulded by ice. Above the metamorphic rocks, in the plains of Canada and the United States south of the St. Lawrence, and around lake Ontario and lake Erie, the Silurian and Devonian strata lie nearly horizontally, but slightly inclined to the south. Consisting of alternations of limestone and softer strata, the rocks have been worn by denudation into a succession of terraces, the chief of these forming a great escarpment, part of which, by the river Niagara, overlooks Queenston and Lewiston, and capped by the Niagara limestone, extends from the neighbourhood of the Hudson to lake Huron. Divided by this escarpment, the plains of Canada bordering the lakes and part of the United States thus consists of two great plateaux, in the lower of which lies lake Ontario, lake Erie lying in a slight depression in the upper plane or table land, 329 ft. above lake Ontario. The lower plane consists mostly of Lower Silurian rocks, bounded on the north by the metamorphic hills of the Laurentine chain. The upper plane is chiefly formed of Upper Silurian and Devonian strata. East of the Hudson, the Lower Silurian rocks that form the lower plane of Canada become gradually much disturbed and metamorphosed, and at length, rising into bold hills trending north and south, form, in the Green Mountains, part of the chain that stretches from the southern extremity of the Appalachian Mountains to Gaspé, on the Gulf of St. Lawrence. Between the planes of the lakes and this range, the steep terraced mass of the Catskills, formed of old red sandstone, lies above the Devonian rocks, facing east and north in a grand escarpment.

The whole of America south of the lakes, as far as latitude 40°, is covered with glacial drift, consisting of sand, gravel, and clay, with boulders, many of which, during the submergence of the country, have been transported by ice several hundred miles from the Laurentine chain. Many of these are striated and scratched in a manner familiar to those conversant with glacial phenomena. When stript of drift, all the underlying rocks are evidently ice-smoothed and striated, the striations generally running more or less from north to south, indicating the direction of the ice-drift during the submergence of the country at the glacial period. The banks of the St. Lawrence, near Brockville, and all the Thousand Islands, have been rounded and *moutonnée* by glacial abrasion during the drift period.

The submergence of the country was gradual, and the depth it attained is partly indicated in the east flank of the Catskill mountains. This range, near Catskill, runs north and south, about 10 or 12 miles from the right bank of the Hudson. The undulating ground between the river and the mountains is seen to be covered with striations wherever the drift has been removed. These have a north and south direction; and ascending the mountains to Mountain House, the speaker observed that their flanks are marked by frequent grooves and glacial scratches, running not downhill, as they would do if they had been produced by glaciers, but north and south horizontally along the slopes, in a manner that might have been produced by bergs grating along the coast during submergence. These striations were observed to reach the height of 2,850 ft. above the sea. In the gorge, where the hotel stands at that height, they turn sharply round, trending nearly east and west; as if at a certain period of submergence, the floating ice had been at liberty to pass across its ordinary course in a strait between two islands. During the greatest amount of submergence of the country, the glacial sea in the valley of the Hudson must have been between 3,000 and 4,000 ft. deep, and it is probable that even the highest tops of the Catskills lie below the water.

In Wales it has been shown that during the emergence of the country in the glacial epoch, the drift in some cases was ploughed out of the valleys by glaciers; but though the Catskill mountains are equally high, in the valleys beyond the great eastern escarpment the drift still exists, which would not have been the case had glaciers filled these valleys during emergence in the way that took place in the passes of Llanberis and Nant-Francon, and in parts of the Highlands of Scotland.

It has been stated above that the upper plain around Lake Erie, and the lower plain of Lake Ontario, are alike covered with drift. Part of this was formed, and much of it modified, during the emergence of the country. In the valley of the St. Lawrence, near Montreal, about 100 ft. above the river, there are beds of clay, containing Leda Portlandica, and called by Dr. Dawson, of Montreal, the *Leda clay*. Dr. Dawson is of opinion that when this clay was formed the sea in which it was deposited washed the base of the old coast line that now makes the great escarpment at Queenston and Lewiston, overlooking the plains round Lake Ontario. It has long been an accepted belief that the Falls of Niagara commenced at the edge of this escarpment, and that the gorge has gradually been produced by the river wearing its way back for 7 miles to the place of the present falls.* In this case the Author conceives that *the falls commenced during the deposition of the Leda clay, or near the close of the drift period*, when during the emergence of the country the escarpment had already risen partly above water. If it should ever prove possible to determine the actual rate of recession of the falls, we shall thus have data by which to determine approximately the time that has elapsed since the close of the drift period; and an important step may thus be gained towards the actual estimate of a portion of geological time.

REVIEWS.

Deane's Manual of the History and Science of Firearms. London: Longman, Brown, Green, Longmans, and Roberts, Paternoster-row. 1858.

This book, which it is fair to presume has been got up by or for Mr. Deane, of the late firm of Deane, Adams, and Deane, contains some useful information and advice on the subject of firearms, and an interesting retrospect and synopsis of inventions in gunnery, projectiles, &c., though, we think, a better arrangement and more extended field might have been adopted in treating of these subjects, and also a better style of typography, engraving, paper, &c.; but those, doubtless, will not be forgotten, and more time will be bestowed on the work, should another edition be called for.

A considerable portion of the work is devoted to introductory matter of a very elementary character—to descriptive sketches of non-explosive projectile weapons, and to the history of fire-arms and inventions in gunnery and projectiles, information about gunpowder and the modern discoveries in explosive agents, and their application to fire-arms; then follow chapters on the general principles on which the construction of fire-arms is based; on the trajectory or line of translation described by projectiles during their flight; and numerous other matters connected with shot-guns, as well as rifles, and such like arms, their manufacture and management.

From these introductory matters the author proceeds to deal with what we presume to be the "end and aim" of the book before us—viz., the division of the work which relates to revolving fire-arms; and with this division of the book we will hereafter deal more in detail.

The author, in treating of the various descriptions of breech-loaders, gives, in our opinion, undue prominence to "Prince's system," which, so far as our practical experience goes, is infinitely inferior, in all that should be considered as merit in such arms, to the "Terry" breech-loaders, which are not honoured by mention in this "Manual of Fire-arms." Upon noting this circumstance, we at once referred to the title-page to ascertain if we had not

* The details on which this belief is founded may be found in the writings of Professor Hall, of Albany, and Sir Charles Lyell.

misread the date "1853" for "1858," for surely no one practically and thoroughly conversant with the progress of the experiments with breech-loading fire-arms, would ignore the results of such experiments, by entirely omitting mention of the Terry breech-loading arms—in our opinion—the best, mechanically speaking, of all the breech-loading arms which we have tried, or of which we have witnessed trials. True it is that at page 189, mention is made of a breech-loader, dated 1855, as "Brant, since Calisher and Terry's Rifle;" but no description of it is vouchsafed, whilst to the Prince breech-loader (which is understood to have been condemned) several pages are devoted; but no description is given of the most successful of all of the breech-loading contrivances, "Terry's Patent."

We now proceed to deal with the subject, or rather the object for which it is only reasonable (after perusing the book carefully) to believe the book was written—viz., to bring prominently before the public the Deane-Adams revolving arms; and as comparison between the Deane-Adams and the Colt arms have been drawn, we do not hesitate to deal with that branch of the subject.

We, therefore, proceed to make a few remarks where we see necessary, and especially by "balancing" against the numerous enumerated advantages of the "Deane-Adams" a corresponding number of those claimed as belonging to the Colt pistol.

We perfectly agree with the remarks at page 166, "that it is a duty to point out and correct the belief that the '*invention*' of revolving breech loaders belongs to Colonel Colt," especially as we have the Colonel's own words at the Institution of Civil Engineers, in November and December, 1851, where, in his interesting Paper "on revolving breech firearms," read at that Institution, he states that "he had been aware, since 1835, of the existence of ancient examples of repeating firearms, but it was not until he came to England in 1851 that he had been able to devote any attention to their chronological history." Of one thing, however, we are quite certain, and that is, that the gallant Colonel may safely claim the merit of having produced the first efficient, safe, self-acting revolver, free from the objections and defects to which all the former known revolvers were liable.

This object had not been attained until he brought his excellent arms to their present high state of perfection, which, it may be remarked, was attained in 1846, and that the arms now sold and made at the present day are identical with those of 1846. This will be at once admitted on a careful perusal of the before-mentioned interesting Paper.

We may also observe that prior to 1840 very little attention was paid to the revolver in England, there being no self-acting revolving weapon, with cylinder breech, prior to Colt's, the only revolver being the old-fashioned, dangerous, six-barrelled, cumbrous affair, and it is chiefly owing to the Colonel's success and skill in producing and manufacturing a *safe and reliable weapon*, that our gunmakers turned their attention to it; and whilst they have been changing its form and modifying its proportions almost daily since 1840, Colt's yet retains the form and efficiency given to it in 1846—the results of experience in its use, and the constant attention paid to produce a safe and perfect weapon. It also appears that the Colonel adopted, in the year 1836, the system of continuous fire by simply pulling the trigger; but this was soon discarded, as use gave proof of its dangerous inefficiency, liability to premature discharge, and the gradual weakening of the spring. This plan was, however, resuscitated some few years since in "Adams'" revolver, and it is used in "Deane-Adams'" and in various imitations of Colt's; but we do not see that it is safer or better now than when laid aside as dangerous and inefficient by Colt some fifteen years ago.

One thing in this work rather amuses us: in speaking (page 195) of the "Mariette" revolving pistol, one which revolved and fired by the continuous pull at the trigger, the author says, "The continual rotation of the barrels, and the perturbation occasioned by its mechanism, require that it should be fired at close quarters, and this arm being one of but little precision of fire, is of very secondary use, except in cases of defence in close contact with an adversary;" while in advocating the use of the "Deane-Adams" revolver, particular attention is called to its possessing this very condemned faculty as a cause of its superiority over Colt.

The avoidance of the above system is that which makes Colt's weapon so reliable and efficient, and in the hands of a cool person a most deadly weapon, from its unerring accuracy and strength of fire, it being, in fact, a "small pocket rifle" (*vide* "Busk's Rifleman's Manual").

We pass over the remarks at page 205, relating to the "irregularity of form" of Colt's revolver, feeling sure that in the hands of an unprejudiced person it will not suffer by the comparison; and as to its liability to premature discharge "from the effects of a blow," we do not apprehend such an accident, if the simple means provided to prevent all such mishaps—viz., the pins between the nipples, are used to let the hammer down on, instead of the nipple itself; whilst the provision of a "safety bolt" to lock the cylinder, provided in the other weapon, we do not think an advantage, inasmuch as it would, in the hurry and excitement under which one would probably be called on to use the weapon, be overlooked; whereas in Colt's, it has only to be cocked and then pull the trigger—an operation naturally performed under all circumstances without even thinking.

The enumeration of the "advantages" possessed by the "Deane-Adams" revolver can only be appreciated when compared with an equal number of advantages assumed to belong to Colt's, and which are given as under:—

ADAMS.	COLT.
1. "Has three sizes, but are not so long or so heavy, and have not the unpleasing brass furniture which overloads these."	1. Has five sizes, the two largest having *six shots each*, and the smaller *five shots*. None of them have the "brass furniture" alluded to, that having been used only in early manufacture: respective weights, 18 oz., 22 oz., 24 oz., 26 oz., 40 oz., &c.
2. "The bore of the Adams revolver is much larger."	2. This is no advantage in close combat. Colt's largest is the same bore as the Adams. The other sizes admit of a greater number of rounds being carried with the same weight of ammunition.
3. "The fire of Adams' pistol is so much more rapid."	3. This is no advantage, as it is not needful to shoot five shots into an adversary to kill him, to say nothing of the inaccuracy of a "rapid fire."
4. "The Adams is always ready for an instantaneous multiple fire."	4. So is the Colt, especially as it is not fitted with the stop bolt and several triggers to pull, all which are likely to prevent the use of the weapon in a hurry.
5. "The Adams' revolver is loaded much more rapidly than the Colt, as the bullets may be inserted by a simple pressure of the finger."	5. With this system of loading, it may be; but the *bullets fall out*, especially when riding, and they jar forward in shooting, hindering the rotation of the cylinder; whilst Colt's, from being *forced* down by a ramrod, never get loose or fall out, and the charge is effectually preserved against damp, the bullets being *sealed* by the pressure.
6. "The Adams revolver is much more solid than the Colt, for it never becomes shaky from the defective connection of the wood with the lock of the pistol."	6. We have never found or heard of such an occurrence, and we do not think the Adams is more solid.
7. "Artistically speaking, it is more elegant, more attractive to the eye, of a more pleasant form to the hand."	7. This is a question; and to our eye Colt's is much more attractive, from its better proportion and compactness, and more pleasant to the hand from its poise, the stocks being either plain or chequered.
8. "This form of Adams revolver admits also of the adaptation of a convenient magazine for caps in the butt of the stock or handle, which the metallic band surrounding the wood in the Colt pistol handle wholly excludes."	8. We do not see any advantage whatever in this; had it been an improvement, there can be no doubt it would have been adopted; but as it weakens the stock, which cannot be too solid to resist the recoil, it is very questionable.

We can only say that the advantage of possessing *six shots* in a weapon rightly handled, in place of *five*, would, in our opinion, more than counterbalance any disadvantage under which the Colt might labour; and with regard to the "intermittent system" of Colt, so much deprecated in this work as a disadvantage, we observe that the "Deane-Adams" has been fitted so as to be used as such at the will of its possessor.

The following are the results of a comparison of the relative merits and advantages of the two weapons:—

COLT.	DEANE-ADAMS.
1. Barrel made of best steel: cylinder, ditto.	1. Barrel made of iron: cylinder, ditto.
2. Nipples and caps protected by the ball of the lock frame, so that nothing can touch them.	2. No protection for the nipples; caps likely to be rubbed off by least friction when riding, or putting the pistol into the holster.
3. Barrel easily separated from the lock, for washing and cleaning.	3. Barrel and lock joined, and cannot be washed, as the water would enter the lock, and rust the parts.
4. Lock frame hardened.	4. Lock frame cannot be hardened, being attached to the barrel.
5. Ratchet, for revolving the cylinder, made from the solid substance of the cylinder itself, not likely to be injured, cannot become detached, and is well protected from the fire of the caps.	5. Ratchet, for revolving cylinder, is a detached piece, fastened to the cylinder by two small screws, and exposed to the fire of the caps, and consequently liable to be injured and come off.
6. Simplicity of taking the lock to pieces and putting it together.	6. Difficulty of taking the lock to pieces and putting it together, except by a person with long experience in their use.
7. Hand or lifter protected from the fire of the caps.	7. Open space where hand or lifter acts not protected from the fire of the caps.
8. Superior strength of the main-spring, = 10 lbs.	8. Strength of main-spring about 3 lbs.: works appear too delicate to admit of a stronger spring.
9. Main-spring easily removed by the thumb.	9. Main-spring requires a spring cramp to enable it to be removed and put in place.
10. Easily repaired, as parts that will fit any sized pistol can be sent all over the world: each piece of each pistol is an exact repetition of another of the same size.	10. Cannot be repaired, except by the workmen at the place where made.

COLT.	DEANE-ADAMS.
11. Provision for safety in carrying by a pin between each of the nipples, on which the hammer is let down; pistol instantaneously ready for use by simply cocking it.	11. Provision for safety a small bolt which locks the cylinder, likely to be forgotten in a hurry, and to lead to disastrous consequences from not being ready for use at a moment's notice.
12. No top bar, or anything at all likely to prevent the cylinder (which rotates on a base pin attached to lock-frame) from revolving.	12. Thin top bar of lock frame comes over the top of the cylinder, a blow on which effectually cripples the pistol, by preventing the revolution of the cylinder.

At page 209 we get a new geometrical term, a "quadrilateral triangle." We shall have pleasure in inspecting a copy of the "Edition of Euclid" which has advanced so rapidly as to have "invented" such a form, though we are not quite clear as to the author's meaning.

Why the author of this "Manual of Fire-arms" should have adopted the expression "aberrant," and applied it to breech-loading arms, we are at a loss to conceive. Under the head "Fire-arms of Aberrant form," the author treats of—first, breech-loading, and second, revolving chambered arms. Surely the author might have selected a better, truer, and more common-sense expression by which to distinguish these forms of weapons. In the introductory observations preceding the division of the work just referred to, the author, after indulging in a discursive and somewhat high-flown strain, and dealing very extensively in metaphorical expressions, finds it necessary to apologise to his readers in the following words :—"We beg pardon of the reader for a digression of thought which he may perhaps consider as aberrant from our subject matter, &c." Now here the word *aberrant* is, in our opinion, very properly and truthfully used.

In making the foregoing remarks we beg distinctly to state, that we have not done so with a view to make invidious comparisons solely; but The Artizan being a mechanical publication, we felt it right to examine, as practical mechanics, the two weapons so prominently brought forward—especially as such comparison has been invited by the remarks of the author; and having done so, cannot avoid recording the results of our comparisons. However, we, and doubtless all our readers, will agree with the remarks on revolvers at page 215, "that it must be admitted that whether of intermittent or continuous action, they are, in their respective degree, alike admirably adapted for attack and defence, and infinitely superior to the pistol they have superseded."

The concluding chapter on muzzle-loading fire-arms with grooved or rifled barrels contains much interesting matter, and, on the whole, will afford both instruction and amusement to those whose pursuits or profession bring them into contact with such weapons; and if the writer's remarks at pages 284 and 285, on the colour and clothing of the Rifle Brigade and the adjustment of the length of stocks of the arms served out to the men, are attended to by those who have the control of such matters, some good will have resulted from the publication of the "Manual of Fire-arms."

Rudimentary Dictionary of Terms used in Architecture Civil, Architecture Naval, Building and Construction, Early and Ecclesiastical Art, Engineering Civil, Engineering Mechanical, Fine Art, Mining, Surveying, &c. To which are added Explanatory Observations on Numerous Subjects connected with Practical Art & Science. 2nd edition, corrected and improved, pp. 564. John Weale: London.

The first edition of this rudimentary dictionary was deservedly popular, and after going through the second edition with great care, we are enabled to discover so many additions and improvements, that we cannot doubt it will meet with still greater success, which it thoroughly deserves. The corrections have been made with great care, and the additions have been very prominently introduced.

The Carpenter and Joiner's Assistant: a Complete Course of Practical Instruction in Geometry, Geometrical Lines, Drawing, Projection, &c. Blackie and Sons, Glasgow and London.

We have received the 11th and 12th parts of this really excellent work. The high quality of the illustrative examples and textual matter which we formerly stated, in noticing the earlier numbers, characterized this work, is fully maintained.

A Treatise on Rope Making. By Robert Chapman. Spon, Bucklersbury. 1858.

This little treatise professes to give a description of the methods and details of rope-making, as practised in private and public ropeyards, and to supply the best rules which have been adopted in the selection of the material, the spinning, tarring, strand making, and laying up into ropes and cables.

The author has collected together an amount of information which, published in the present form, is useful, chiefly from the small size of the book in which it is contained. It is, however, to be regretted that the Author did not devote more time to the careful compilation of the work, and, by extending its practical usefulness as a work of reference, make it what it might have been—viz., "A Hand-Book for Ropemakers."

A Manual of Applied Mechanics. By William John Macquorn Rankine, LL.D., C.E., F.R.SS.L. & E., &c., President of the Institution of Engineers in Scotland, and Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. Richard Griffin and Co., London and Glasgow. [Second notice.]

It has been often stated, both by journalists and statesmen—whether wisely or not we cannot now determine—that this is an age of progress and of development, an age in which no subject of thought can remain long in a permanent position.

Every branch of science and literature must be in abeyance, and ready at any time when called upon to undergo certain transmutations to suit the urgent demands of a restless generation, that is seeking after something new immediately after it has satiated its appetite upon that which is considered to be old.

The railway system, the electric telegraph, the *Leviathan*, and a thousand other novel and important inventions, the offspring of high mental activity, are doing their work; they are changing the aspect of mind and matter—that is, of the mental and material world—first, by the equal distribution of the fruits of the earth; secondly, by the rapid interchange of thoughts and feelings, even between rulers removed from each other by great waters; and thirdly, by applying a most powerful stimulant to the public mind, and thereby inducing great mental exertion in every possible direction, and of every possible magnitude.

There can be no doubt that such a state of things is calculated to afford a strong temptation, and one not easily to be resisted, especially by those who may be desirous of becoming distinguished as authors, and supplying, in the cheapest form and on the easiest terms, intellectual food to satisfy the ever-increasing appetite for novelty, wisdom, and knowledge.

For this purpose, every subject which has engaged the attention of philosophers, poets, and statesmen, from the earliest ages of civilization to the completion of the Atlantic telegraph, must be laid tributary; their laws and organization must be moulded into shapes and dispositions entirely unknown and unheard of in the history of the dark ages, to meet the special present requirements of a people anxious for change and material enjoyments. They must indeed be dull of comprehension who fail to observe the apparent (at least) intense desire manifested by men possessing great social status and commanding abilities, that knowledge shall cover the earth as the waters cover the sea, and that artizans of every grade and distinction shall not henceforth be masters of their own craft, unless they can assign, in scholastic phrases and logical sequences, the reasons—the why and the wherefore—for their more than magical operations.

The promulgation of these sentiments amongst the working classes is producing mighty changes, whether for good or for evil remains yet to be solved. There is also visible in the distant horizon an unmistakable tendency towards the questionable appropriation of practical science to our highly valued and respected seats of learning, the universities. But we do hope that teachers and professors of practical science, as it is called, in colleges and public schools will not, in their desire to promote to a very limited extent the union of pure science with practical experience, lose sight of the important fact which is every day pressing itself upon our attention, that a *living* and an *earning* knowledge of any craft can be obtained only by one means, viz.—thorough industry and diligent application in the workshop and factory. The political capital of the day is, however, education and examination; and so strong and so swiftly does the latter follow the former, that we are constantly being reminded of the foolish husbandman, who invariably uncovered the seed in the evening which had been sown in the morning, for the express purpose of ascertaining the amount of its growth in magnitude and direction. The over-anxious husbandman, by the constant practice of this unwise procedure, reaped no fruit. Whether these prevailing tendencies to education are calculated to promote the ultimate happiness and welfare of the community, or whether the art of right and vigorous thinking is not on the decline in this country, notwithstanding the apparent enthusiasm which is exhibited by certain parties in the distribution of science amongst all classes of society, are important questions respecting which we are not now called upon to decide. In this state of public feeling amongst the engineers, artizans, and workmen of all grades, we are not disappointed in the least to find they are ready to devour the contents of a book which possesses the captivating title of "*Applied Mechanics.*" And more especially when it is known to be written under the most auspicious circumstances, by the most gifted of the sons of the University of Glasgow; and also for the express purpose of forming a portion of the "Encyclopædia Metropolitana," a work which is destined to convey to distant ages the present knowledge of the subjects of which it treats.

In justice to Mr. Rankine it may be stated, that his investigations on the properties of steam, and other philosophical subjects requiring great abilities, mathematical profundity and acumen, published in the transactions of learned societies, have given him a deserved reputation and an acknowledged position amongst the best and foremost of the physicists of the age. He is frequently held up—whether justly or not we cannot say—as an honour to the university to which he belongs; and like his great prototypes Pindar and Volta, throws a halo of glory round the city in which he resides.

If, then, perfection is expected to flow from an author, surely it will be no stranger in a book on "Applied Mechanics," written by a man so distinguished and honoured, and for the purpose of transmitting to distant ages the full and complete knowledge of engineering science, as it exists in the middle of the 19th century amongst the most successful of the faculty. Now as examinations are the hobbies of the day, on which everyone that can afford is riding, all, from the Prime Minister down to the menial that serves as a kitchen maid (particular individuals, who are covered with the sacred authority of system, being excepted), must submit to the painful ordeal of having their modes of thought, habits of life, retention of memory, and a thousand other things, inquired into and thoroughly scrutinized, ere they can be entered into any of the branches of the Civil service; and as the book before us differs so much from similar books which issue at intervals from the Cambridge press, both in material and arrangement, and also by the introduction of unusual names and phrases which may or may not have their application in the arts of civilized life, we think that Mr. Rankine should be no exception to the *general* rule, and that his book should be subjected to the severest examination, in all particulars, before it is placed into the hands of practical men, to guide them in their practice, or even into the hands of students, as a text-book on an important subject.

Viewing the book before us in this light, we purpose, to the best of our judgment, to examine thoroughly into its merits and demerits, ere we launch forth indiscriminate praise or condemnation.

And for the accomplishment of this task, it will be necessary to make the following inquiries:—

1st. What is the object aimed at by the author—that is, for what purpose has the book been written?

2nd. In what manner have the objects aimed at been realized with respect to the quality and quantity of material used, and also its arrangement?

3rd. Is the logic of his definitions, the force of his demonstrations, clear and convincing, either to the practical man, or to the man of pure science?

1st. If, then, the response to these inquiries is not always such as would reasonably be expected from the high reputation of the author, or such as he would be anxious for the public to hear, still we do hope, from the respect and consideration due to the distinguished position of Mr. Rankine, to state our convictions and strictures upon his performances respectfully, but firmly; and also to throw away, as much as we possibly can, the prejudices and partialities which may have crept unconsciously over our minds by the constant perusal of Cambridge works on similar subjects.

The preface does appear not to leave us in doubt respecting the object of the Author, for we are told on the very threshold, "the object of this book is to set forth, in a compact form, those parts of the science of mechanics which are practically applicable to structures and machines;" and hence the title of the book, "Applied Mechanics." It is quite obvious, even to the merest tyro in mechanical and mathematical science, that from the general aspect of the Table of Contents, and other more substantial indications, we shall differ widely from the talented author in our notions of "*applied mechanics*." Shall we be incorrect or, rather, not in accordance with the views of practical and most theoretical men, if we affirm that "*applied mechanics*," in the ordinary acceptation of that phrase, conveys to the mind the idea of the practical arrangement of machinery which is to connect the power applied with the resistance to be overcome, and the useful work to be done? We think not, however much Mr. Rankine's peculiar and original notions may militate against us. We doubt very much, notwithstanding the great ability and learning which have been exhibited in their construction, whether the formulæ which represent the equation of conjugate stress, potential energy of elasticity, ellipsoid of strain, general differential equations of continuity and unsteady motion, ellipsoid of inertia, superposition of small motions, and a thousand such-like things which may be found in this volume, can be justly designated, even by the most enthusiastic students of science, "applied mechanics."

These may be, and no doubt they are, legitimate subjects of inquiry, and will suit amazingly the tastes of college professors and students; but they have no place, we conceive, in practical science. There are but few, if any, engineers that would not shrug their shoulders at the very sight of the equations contained in the "*Applied Mechanics*;" they would rest securely enough from active employment behind an intrenchment of equations of such formidable dimensions. We would ask earnestly the important question—Would not a practical man, looking for the first time into a book with such a title, expect to find a detailed exposition of the mechanical arrangements which have been constructed and adopted for the accomplishment of engineering and architectural projects—a thorough investigation, based on the simplest principles of geometry and ordinary algebra, of those mechanical arrangements—a critical description of their aptitude, or otherwise, for the purpose they were designed? We think he would expect all this; and we think further, that his expectations would not be realised by the reading of Mr. Rankine's book; for, instead of that which he might reasonably anticipate, he will find treatises of abstract statical and dynamical sciences, treated with all the complexity of the differential and integral calculus, in a way suitable enough in some cases for an aspiring student of Cambridge, but not at all adapted to supply the wants of practical engineers. And what we conceive to be a still greater objection is, that he will find in its pages certain crotchets, floating, indeed, in the minds of philosophers, but which have no place in applied mechanics, nor even in recognised theoretical standard works on the subject. This may possibly be objected to on the ground that Mr. Rankine's learning and abilities, position and prestige, eminently qualify him to be taken as a guide in writing, for the instruction of engineers and practical men, suitable works on elementary sciences. We shall be better able to give an opinion on this point after examining more fully into the contents of the book; but generally we should be inclined to think, that original investigations and indomitable perseverance in the pursuit of one object will, to a certain extent, disqualify any man for the execution of such a task. A man must know almost everything which has been done by others, but he must be entirely ignorant of his own performances and his own crotchets, before he can be properly qualified to write upon elementary subjects with advantage either to the public in general, or even to his own pupils. It is an acknowledged fact that great men, with a few exceptions, are amongst the most incapable of writing on any subject didactically; they can form but a faint idea what to leave out and what to put in, so that the student may not be left too bare of instruction on the one hand, and on the other be inundated with verbose explanations too tedious to be entertained. In one case he becomes discouraged and disheartened, and in the other he is prevented from the pursuit of his studies with that pleasure which is absolutely necessary to make satisfactory progress.

After taking a minute survey of the matter and arrangement, we shall be much surprised if the "*applied mechanics*" is adopted as a text-book in colleges or public schools beyond the limits of the University of Glasgow. In our opinion, it is not adapted to meet the wants of the practical man, and we are sure the purely scientific man will find many Cambridge and Dublin books better suited to his purpose. Hence, the real object of Mr. Rankine cannot have been to furnish practical men with useful information in a clear understandable style, as the title of his book would lead us to infer; nor to furnish a text-book for students, because he has fearfully failed in both these objects. There is now no alternative but to ask, has he written it for the purpose of affording him an opportunity of placing his own discoveries in a prominent position before his readers? Unfortunately, he has bestowed great pains on his own peculiar discoveries, and left the other parts of his performance in a meagre condition, a circumstance which is rather ominous, and favours the idea that ambitious motives must have produced their influence in prompting him to the execution of his task. This proceeding may have excited, and in some cases extorted, the exclamation—What a clever man Mr. Rankine must be!—he has succeeded in writing a book on "*applied mechanics*," and such is the profundity of its contents, that those best acquainted with practical applications of mechanics cannot comprehend it.

Whatever Mr. Rankine's preface may say to the contrary, we cannot resist the conviction that ambition, the most captivating and the most unscrupulous in its demands, has exacted from him the "Manual of Applied Mechanics." Surely, if the aim had been to advance the knowledge of practical subjects, by making their descriptions and theory more attractive to the practical student, then the book would have presented a widely different aspect from the present, and one which would have invited the attention of practical men, instead of being, as it now is, highly repulsive to them. We are, then, inclined to adopt the latter view, as we cannot think that Mr. Rankine could so far forget the object for which he was labouring as to write a book that is neither useful to the practical man, nor to the student as a text-book.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

WILLIAMS (C. W.)—An Elementary Treatise on the Combustion of Coal and the Prevention of Smoke, Chemically and Practically considered; with an Appendix containing the Report on the Newcastle Steam Coal, and the Adjudication of the Premium of £500. By C. Wye Williams. 12mo, pp. 260, cloth, 3s. (Weale's Rudimentary Series.) (Weale.)

HASKOLL (W. D.)—The Practice of Engineering Field Work applied to Land, Hydrographic, and Hydraulic Surveying and Levelling for Railways, Canals, Harbours, Towns, Water Supply, Ranging Curves and Centre Lines, Gauging Streams, &c.; including the Description and Use of Surveying and Levelling Instruments, and the Practical Application of Trigonometrical Tables; illustrated by Plans and Diagrams. By W. Davis Haskoll. 8vo, pp. 330, cloth, 20s. (Atchley.)

HUDSON (R.)—The Land Valuer's Best Assistant; being Tables on an Improved Plan for Calculating the Value of Estates: to which are added, Tables for Reducing Scotch, Irish, and Provincial Customary Acres to Statute Measure; also Tables of Square Measure, and of the Various Dimensions of an Acre in Perches and Yards, by which the Contents of any Plot of ground may be ascertained without the Expense of a regular Survey, Miscellaneous information on English and Foreign Measures, Specific Gravities, &c. By R. Hudson. New edit. with Additions and Corrections, oblong, bound, 4s. (Simpkin.)

ENGINEERING and MECHANIC'S PORTFOLIO of Engineering Engraving; useful to Students as a Text-Book, or a Drawing-Book of Engineering and Mechanics; being a series of Practical Examples in Civil, Hydraulic, and Mechanical Engineering. 50 Engravings on a Scale for Drawing and Practice, with Explanatory Details, &c.; selected as an Elementary Introduction to the Professional Student in the commencement of his career. 4to, cloth, 28s. (Weale.)

SPURGIN (J.)—Drainage of Cities; reserving their Sewage for use, and keeping their Rivers clean, being especially applicable to the Thames; with an illustrating Plan. By John Spurgin, Esq., M.D. 8vo, pp. 44, sewed, 1s. 6d. (Hodson.)

STEAM NAVIGATION: Vessels of Iron and Wood; the Steam Engine; and on Screw Propulsion. By W. Fairbairn, of Manchester; Messrs. Forrester, of Liverpool; J. Laird, of Birkenhead; O. Lang, of Woolwich; Messrs. Seaward, of Limehouse, &c. &c.; with Results of Experiments on the Disturbance of the Compass in Iron-built Ships. By G. B. Airey, Astronomer Royal. Text in 1 vol. 4to, boards, and Atlas of 75 Plates, separate in folio, 52s. 6d. (Weale.)

*APPLETON'S Cyclopædia of Drawing, designed as a Text-Book for the Mechanic, Architect, Engineer, and Surveyor; comprising Geometrical Projection, Mechanical, Architectural, and Topographical Drawing, Perspective, and Isometry. Edited by W. E. Worthen. Imperial 8vo. (New York), cloth, London, 36s.

A TREATISE on the Application of Analysis to Solid Geometry. Commenced by D. F. Gregory, M.A., late Fellow and Assistant Tutor of Trinity College, Cambridge; concluded by W. Walton, M.A., Trinity College, Cambridge. 2nd edit. revised and corrected, 8vo, 12s. (Bell and Daldy.)

CHAPMAN (R.)—A Treatise on Ropemaking, as practised in Private and Public Ropeyards; with a Description of the Manufacture, Rules, Tables of Weights, &c., adapted to the Shipping, Mining, Railways, Builders, &c. By Robert Chapman. 12mo, pp. 100, cloth, 2s. (Spon.)

BRYSON (J. M.)—Remarks upon the Drainage of London. (J. S. Hodson.)

FULLOUR (S. W.)—The Marvels of Science, and their Testimony to Holy Writ; a popular System of the Sciences. (Routledge.)

NICHOL (J.)—A Geological Map of Scotland, from the most recent authorities and personal observations. (Blackwood.)

TEMPLETON (W.)—The Millwright and Engineer's Pocket Companion; with Lithographic and other Illustrations. Corrected by Samuel Maynard. 12th edition. With a New Table of Fractional Numbers. 12mo, cloth, 5s. (Simpkin and Co.)

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]—ED.

ON STEAM-SHIP PROPULSION. *

To the Editor of The Artizan.

SIR,—"G. J. Y.'s" Paper, published in the July Number, leads to several conclusions: First, that notwithstanding his numerous perversions and contradictions, he is to be considered as arguing in good faith, and believing in what he writes; secondly, as to the necessity of agreement on first principles before attempting to discuss theories in which they are involved; and, thirdly, as to your willingness to afford space for the discussion of those principles.

"G. J. Y." considers himself possessed of a qualification which he names "cunning of fence," and we are quite aware of efforts to employ a style of argument supposed to be exercised by legal gentlemen when trying to cajole a

* For want of space last month, the above, together with other communications from correspondents, and several interesting scientific papers, were obliged to be omitted.

bemuddled and averagely stupid jury. The object of this cunning fence is to appear to be right, and has been known decisively to influence interests, monetary or otherwise, unhappily dependent on the opinions of such a jury.

In a discussion on a purely scientific question, where the intrinsic difficulties render a direct solution nigh hopeless—where we ought to approximate to the truth by careful and conscientious efforts to apply first principles, and be prepared to modify our deductions when new ideas suggest stricter applications of those principles—cunning fence is an admitted nuisance, and a despicable mode of advancing truth, and hence generally found enlisted in the service of error. "G. J. Y." appears to me to have no fixed idea of the meaning of terms used by himself, and may not understand the sense in which they are used by his opponents; but, as he presumes to maintain his mathematical and mechanical pretensions by filling column after column with an undue allowance of his peculiar *Thersites* qualifications. This "odious habit" I attempted to correct by undeceiving him as to his boasted ability to sport with shallow thinkers, and by the endeavour to impress on him that a theory might have a basis beyond his depth; and hence, before proceeding to answer an opponent's arguments by derision, he ought to be sure that they had not a well-known meaning, his misconception of which turned his derision against himself. This procedure on my part he makes the ground of a few personal observations, which I shall not waste space in noticing. He is somewhat offensive at best, and, as might be expected, *worse when stirred.* I would suggest this latter phrase to him as the heraldic reading of "*Peor es meneallo.*" His want of something of the *nemo me impune lacessit* stamp was very obvious, and I thought it might suit him, though in Spanish; but I must say that, from a gentleman so very ready with Latin quotations, something better in the way of translation might have been expected. "*The more he moves, the more he muddles it*" is incorrect, excessively garrulous, and wooden.

"G. J. Y.'s" notion, "weight, motion, and time, are the elements of WORK," I answered with the direct contradiction of Smeaton and Poncelet, who in effect declare that force and space are alone the elements; and I gave the latter's explanation as to why, in speaking of the sustained and uniform work of motors, we considered the work developed in a definite period instead of the whole work. "G. J. Y." notices them so far as to multiply the space occupied by the extracts by four, and then declares he would be fully justified in assuming that I declare 33,000 lbs. lifted 1 ft. high in any time is a H.P.

It appears that his idea of justification disdains to notice the consideration that mechanicians, when they add one word to another, generally mean something by the operation, and that power and horse-power, though in ordinary language sometimes used indiscriminately, may represent different ideas! Smeaton's *power* is defined as the capability of developing that product of force and space which we now name *work* and measure in foot-pounds. Watt's *horse-power* is defined as the capability of developing work at the uniform rate of 33,000 foot-pounds in one minute.

"G. J. Y." will observe that the effect of *horse* upon *power* is to define a certain numerical coefficient, and add the idea of uniform rate of development; but he is defied to show the shadow of a ground for his deduction. A constant force of 1 lb., acting through a space of 1 ft., that is to say, one foot-pound, has the value of that product influenced by the rate at which the space of 1 ft. is described. He tells us, that if described with velocities 10 and 20, the foot-pound in the second case is not a unit of the same value as the other; and, again, that 1 ft. of work at velocity 10 is equal to 2 ft. of work at velocity 20; regrets that he is unable to make me comprehend this mystery, and declares I stultify myself "by arguing that this constant and limited amount of *force* is capable of doing, in the same time, a varying and unlimited amount of *work.*" My reply is, that he neither appears to understand nor believe his own doctrine, far less comprehend mine: and though confusion of ideas is evident in every one of his arguments, he boldly advances assertions of which he neither knows the scope nor meaning.

My whole argument has been an unwavering assertion of the principles which form the basis of all practical mechanics. The product of a definite force and definite space through which it is exerted is the capability which performs *work;* and by this very definition is necessarily a definite quantity, and independent of the time in which the space is described.

The *work* performed, measured by multiplying the resisting force or forces overcome into the spaces through which they are overcome, yields a product which neither theory nor experience ever offered, reasoning or fact indicating even the possibility of a difference between it and the like product of the preceding paragraph.

"G. J. Y's" notions originate in the misconception that a definite amount of force is equal to a definite amount of work. He imagines my argument to be that a definite amount of force may be equal to an unlimited amount of work; whereas I have repeatedly insisted that *no* amount of force is equal to work. The force must be exerted through space, and their definite product may be equated to work, but not the force, nor any portion thereof. The nature of the process by which "G. J. Y." arrives at his deductions, as far as can be gathered from his remarks, appears to be—

A constant force, acting for a second upon different portions respectively of free matter, yields the product of the mass moved by the generated velocity, a constant quantity, which is taken as the measure of the force; and the purest blockhead that tries to study mechanics generally gets to understand this. But the distinction between mass, and the force which gravity exerts upon that mass, which we name its weight, not being sufficiently insisted upon in many works, gentlemen mechanically inspired by an "Atwood's machine" are peculiarly liable to fall into the mistake that mass and weight are "equal" and "identical." Again, we describe a velocity by the space which would be passed over in a second, supposing the velocity continued uniform during that time; and hence, the coefficient being the same for both, mass into velocity, equal to a definite force, gets confused into equality, or, at all events, an indistinct notion of being directly proportional to the product weight into space (it should be force into space), otherwise named work. Hence, when "G. J. Y." imagined equal quantities of matter, upon which gravity is exercising the same force of 1 lb., falling with the respective constant velocities of 10 and 20 ft. per second, the undoubtedly equal product of mass and generated velocity, at the point where the force is opposed to the resistance, gets supposed to be equal works done. Further, the velocity being uniform, the work done at the resistance is equal to the work done at the falling matter, and things that are equal to the same being equal to one another, "1 ft. of work at velocity 10 is equal to 2 ft. of work at velocity 20." So says "G. J. Y.," and at next page (170) furnishes a proof that he does not quite believe this doctrine himself.

Referring to the case where a force of 4 lbs. acts upon a system, and the work is wholly accumulated, he writes:—

"The work would go on accumulating as follows:—

"During the 1st second	....	16
,, 2nd ,,	....	48
,, 3rd ,,	....	80
,, 4th ,,	....	112
"Total work accumulated	....	256"

But written out explicitly, according to figures furnished by himself, ought to have been:—

	Constant force.	Space described during the second.	Work done.
1st second	4 lbs.	4 ft.	16 foot-pounds.
2nd ,,	4 ,,	12 ,,	48 ,,
3rd ,,	4 ,,	20 ,,	80 ,,
4th ,,	4 ,,	28 ,,	112 ,,
Total work accumulated	4 ,,	64	256

There is not a hint as to the precious principle whereby 16 "ft. of work" at mean velocity 4 is equal to 48 ft. at velocity 12, 80 ft. at velocity 20, or 112 ft. at velocity 28; he shows that he believes them to be all made up of units of the same value by presenting their sum work 256.

Reproducing "G. J. Y.'s" statements (page 120): "weight, motion, and time, are the elements of 'WORK;' a plane driven through water 10 ft. overcomes the *inertia* of 10 ft. of water. Here *inertia* is the substitute for weight. The motion is 10 ft." And tabulates—

Time.	Motion.	Inertia.	Work.
"1 second	10 ft.	10	10 × 10 = 100
1 ,,	20 ,,	20	20 × 20 = 400"

Now contrast this with the following:—"Mr. Mansel and others who look at facts only through a mathematical medium . . . . overlook the fact that velocity squared *is the motion per second.*" How, in the above, where the velocities are 10 and 20, does he write motion 10 and 20, when, if "velocity squared," they should have been 100 and 400? A proper mathematical *medium* would have put himself in communication with the shade of Newton (or failing that, with his Principia), and, influenced thereby, would not have stuck the name motion above a column meaning space described during one second, and would further have recognised *inertia* as the increment of motion, and as varying in the comparison of the two cases as the squares of, and not as the velocities. "G. J. Y.'s" *medium* "overlooked the fact," but was not thereby made mathematical, still less was it ever sober sense; and as the usual *double refracting* must not be even hinted at, the remaining supposition indicates it to be a confused *medium*, which, having advanced a "preconceived" notion that the power or work expended on the fluid resistance to the motion of a plane, varied as the square of the velocity, presumes to maintain it with the aid of the *medium* of "cunning fence," and, like the daw with the pavonian ornamentation, are not unlikely to attain the elevation and condition usually assigned to scarecrows..

In the case to which "G. J. Y." applies the assertion, "the velocity squared *is the motion per second,*" he shows that the velocities at the end of the first four seconds respectively are 8, 16, 24, and 32 ft.; the mass moved is the quantity of matter upon which gravity exerts a force of 16 lbs., and, by the definition of mass, is half very nearly. The *motions* (by Newton's definition — the product of the mass and generated velocity) at the ends of the respective seconds are, therefore, 4, 8, 12, and 16; and "G. J. Y.'s" alleged fact manifestly false, as these numbers have no relation to the "velocity squared."

In my former reply to the quotation from page 120, I briefly stated that had "G. J. Y." understood the third law of motion, as illustrated by Atwood's "celebrated machine and mathematics," he would have seen that the *inertia* in the two cases varied as the square of, and not as the velocities. Here he thought he caught me napping; so, "notwithstanding the valedictory character of his last notice," he lugs in an Atwood's machine and a host of figures, which go to illustrate a fact no sane man knowing anything about mechanics ever doubts—namely, that in Atwood's, or any other machine, with a given constant force and time of action, the mass moved is inversely as the generated velocity; but he presents this differently, "the inertia overcome is precisely in the inverse ratio of the velocities." "G. J. Y." then tells us—"inertia is proportional to the weight moved;" and under this miserably shallow interpretation takes for granted the point at issue.

Noticing that Baker, from whom he borrows his machine, does not mention the word *inertia,* I give what I believe to be the strict rendering of Newton's definition, as given in his Principia:—"The force which resides in matter is the power that it has of resisting. The body exercises this force every time that there is a change in its actual state of motion, and we may then consider it under two different aspects—either as resisting, inasmuch as the body resists the force which tends to make it change its state; or, as impulsive, inasmuch as the same body makes an effort to change the state of the obstacle which resists it. Thus we are enabled to give to the force which resides in the body the very expressive name of force of *inertia.*"

Let us now take two equal masses, and in the same small time; let one have velocity communicated or varied to twice the extent of the other; it follows from the third law of motion that the forces producing these changes will be also as two to one. And we likewise know by the second law that these forces have each respectively exerted their full action, no matter what these velocities may have been; but to what have they been opposed?—to *inertia*: the "force residing in the body, and resisting a change in its state of motion." How then does it happen if "*inertia* is as the weight moved," or the same in both cases, that we require to employ a double force in the first case? If "G. J. Y." devotes some of his very ill-directed acuteness to this rather important preliminary matter, he will find his notion of *inertia* to be an absurdity, and that a body in every case resists a change in its velocity with a force equal to the product of its mass by the ratio of the increment of the velocity to the time in which it is produced. *Inertia*, as explained by Newton, is to be esteemed as fulfilling the laws of forces, and, like them, mathematically expressed by a product of the "passive principle," mass multiplying, as a coefficient of quantity, the variable element—the ratio of the variation of velocity produced by its action to the time in which it is produced. Hence, *inertia* into its time of action is equal to the increment of motion (previously defined as the product of mass and velocity; but the Latin name *momentum* is much less liable to confusion with velocity). It is this increment of motion which, in the case of a fluid, we recognise as the resistance; and hence the reason why "G. J. Y." (who confuses motion or *momentum* with work) arrives at the conclusion that "resistance is power expended during a small time."

There are persons who have confused notions as to the distinction between *force* and *power*, *work* and *momentum*—who often apply names belonging to the one of these to the other; and when this is objected to, they complacently assume that the objection is directed against some principle that has been too obvious for even them to mistake. The distinction between *force* and *work* is, I think, for any practical purpose, sufficiently implied by the description that *force* is measured in pounds, but that *work* is measured in foot-pounds; and since *power* or *half the vis viva* are well-known terms for capability of performing work, these are also necessarily measured in foot-pounds. In my first letter I stated: the *principle* of *vis viva* in its simplest form asserts that a material particle moving with any velocity *must*, to produce that velocity, have had an amount of power expended upon it proportional to the product of its mass by the square of that velocity; but at the end of page 169, "G. J. Y." writes: "contrast this with Mr. Mansel's simplest application of *vis viva* in its simplest form—his notion that an amount of force must be expended upon a particle to give it any velocity, in proportion to the square of that velocity." He thus changes my word *power* into *force*, notwithstanding my repeated and energetic protests against their confusion, and then proposes to refute me by contrast with Mr. Baker on a totally different question. Now I have always been in complete accordance with that gentleman on *his* subject; and the only contrast is between what I have said and what "G. J. Y." makes me to say.

Had "G. J. Y." wished to know my notion as to what force must act upon a particle to give it any velocity, he might have observed in the January number: "It is a universally admitted fundamental axiom that forces are proportional to the velocities generated in equal times."

Again, in my first Paper (page 211), a few lines below the extract which "J. G. Y." has garbled, I will be found stating, in the inverse problem of motion lost: "The Cartesians, or those who on this point adopted their views," estimated the resistance necessary to destroy motion in the body by the product of the mass multiplied by the velocity. I called this an "unexceptionable" proposition, and its converse is necessarily equally so. For simplicity, considering a practically constant force, it is the principle:—

The product of a constant force, F, into its time of action, t, is equal to the product of the moved free mass, M, by the velocity, V, generated in the given time: algebraically—

$$F t = MV \quad \ldots\ldots (1).$$

Now the force being constant, the velocity varies directly as the time; and hence the mean velocity is $\frac{V}{2}$, but the space described, s, divided by the time is also equal to the mean velocity; hence the geometrical relation—

$\frac{S}{t} = \frac{V}{2}$, and multiplying the respective members of this equation and of equation (1) together, we have—

$$F t \times \frac{S}{t} = M V \times \frac{V}{2}; \text{ or, simplifying, } F s = \tfrac{1}{2} M V^2 \quad \ldots\ldots (2).$$

The value of V in the geometrical relation substituted in (1); or by squaring the members of equation (1), and substituting in the second for V^2 its value derived from (2), yields another equation, often convenient:

$$F t^2 = 2 M S \quad \ldots\ldots (3).$$

Equation (1) is a fundamental axiom of mathematical mechanics, being in perfect agreement with all experience: it expresses the relation existing between *force during time* upon a free mass, the product of the free mass and its generated velocity. This latter product received from Newton the name *momentum*, or quantity of motion.

Equation (2) is another fundamental axiom of mathematical mechanics, and, properly interpreted, is also in conformity with all experience: it expresses the relation existing between *force through space*, the free mass upon which it acts, and the velocity generated at the limit, altogether independent of the time which has been taken to describe the space. Time, as will be observed, does not enter the equation.

Equation (3) is an obvious deduction from equations (1) or (2): it expresses the relation of force and time to mass and space without reference to the generated velocity.

In the simplest language these equations assert the principles:—

A force into its time of action is equal to the product of the moved mass and generated velocity .... (1)

A force into its space of action is equal to half the product of the moved mass by the square of the generated velocity .... (2)

A force into the square of its time of action is equal to twice the product of the moved mass and described space ...... (3)

I have now to extend my remarks in regard to equation (2), whose members have received an unfortunately large number of names. Smeaton called the first member *power*, or *mechanic power*; and another expression of his, *mechanical effect*, applies indifferently to either. The first member is generally recognised by the name *work*, given to it by French mechanicians; and the second, named *accumulated work* by Moseley. Another term for it (much applied in the more recent developments of the subject in its generality (is *energy*; but the most generally known title for the second is *half the vis viva*: this Latin term for the compound relation of force and space having been proposed by one of its first expounders, the illustrious Leibnitz.

The manner in which this mechanical principle was received and understoo-by mathematicians, in my opinion, went a considerable way to the establish, ment of the complacement continental dictum. If you want practical sagacity go to England; but if you want theory, go anywhere else. I briefly mention two facts: John Smeaton, about eighty years afterwards, endeavouring to explain to the Royal Society that, although there was nothing more certain than the principle involved in equation (1), yet the principle involved in equation (2) was certainly quite as correct, far more definite, and really the subject matter of all practical mechanics, he employed no "profound mathematics," but plain English and simple experiment. Mathematicians then and since, much to their own satisfaction, may have "corrected his mistakes:" that is to say, displayed that they had little notion as to what he had talked about, and that they wisely fell back upon equation (1), in which they had found surety. He spoke of work, which he called power; they spoke of force, and confused it with the former.

That is eighty to a hundred years ago, and we now find Dr. Whewell (in bringing the history of the inductive sciences down to the year 1857) stating, in reference to work or labouring force, "This is not a new principle, being in fact mathematically equivalent to the *conservation of vis viva*; but it has been employed by the mathematicians of whom I have spoken (mathematical engineers of France, MM. Poncelet, Navier, Morin, &c., &c.) with a fertility and simplicity which makes it the mark of a New School of Mechanics of Engineering."

The principle of *vis viva*, which "G. J. Y." "repudiated with contempt" and treated with derision (because he thought himself secure of certain cases in which it was not true), has in recent years found its "fertility and simplicity" developed in the highest degree in those very cases which were formerly supposed to prove its absurdity! In the treatment of questions connected with the expenditure of work, whether in fluids or otherwise, it never fails, when we know the conditions sufficiently to be enabled to apply it; rudely this may be at first, but though we may be often baffled in our efforts to combat the various difficulties even in detail, it forms a sure basis of operation and point of departure for renewed efforts.

"G. J. Y." now attempts to double back, and proposes to teach me what *vis viva* means. His explanations are obvious confusion; he juggles with coefficients, but the subject matter of those arithmetical gymnastics is not the subject matter of equation (2). His *work* and *vis viva* are at bottom, but those names applied to the subject matter of equation (1).

But I have intruded too far on your space, and therefore, apologizing, conclude.

I am, &c.,

Govan, Glasgow. Robert Mansel.

To the Editor of The Artizan.

Sir,—In reply to "G. J. Y." I beg to observe that the only question between "G. J. Y." and myself is, whether or not, under the conditions implied by the usual expression "*cœteris paribus*," the formula $P \times V^3$ expresses the mutual relation of power and speed, as applied to the propulsion of a steam-ship. My letter, to which "G. J. Y." takes exception, is, I submit, pertinent to this subject, and I decline to complicate the discussion by taking up the question proposed by "G. J. Y." in all the details of dissimilar circumstances which it would involve.

I am, Sir, your very obedient servant,

Woolwich Dockyard, Chas. Atherton.
21st Sept, 1858.

NOTICES TO CORRESPONDENTS.

R. P. (Hull)—The hydraulic apparatus of Mr. W. G. Armstrong, C.E., of Newcastle, is best suited to the purpose respecting which you inquire.

H. B. (Deventer.)—We have at last obtained for you, and have sent by post, a heavy package of papers, containing all the information wanted.

R. H. D. (Philadelphia.)—We shall be glad to hear from you.

Brick (New York.)—Any information with which you can furnish us will be acceptable.

R. M.—You will perceive that we have this month found space for your letter.

S. Monti.—We regret being compelled, for want of space this month, to omit your very interesting communication, which, together with several other papers, &c., are set up in type. We are desirous of hearing from you further on the same subject.

Q., Alpha, J. (Nottingham), and High Pressure, will be attended to next month.

J. B. (Dublin.)—The matter has been set up, but, unfortunately, want of space has prevented its being used.

William Morris.—Of your patent brick machines, we are unable to do more than express a favourable opinion of the system. We will see what can be done. You may call at the office.

C. E. Freund (Lambeth).—The first subject will be treated of next month.

C. Ritchie.—Call: we will explain the matter to you.

J. Tyrrell (Stamp End).—No. If, however, you will name any plates, we will inform you of their prices.

G. W. (Nottingham).—We will write again to you. We have since obtained part of the information required.
D. Miller (Glasgow).—We shall be glad to hear from you upon any of the matters which come under your observation. We are obliged for the last memorandum, which was used last month.
P. M. and Sons (Glasgow).—We were at a loss to account for the receipt of your letter relative to gutta percha and leather, but now perceive the notice of the invention only appeared in the "List of Patents." We know nothing more of the matter, or should have complied with what otherwise would have been a very reasonable request.
S.—Write to Mr. Richard Roberts.
J. H., Egerton Street, Liverpool.—There have been many patents granted for inventions connected with the manufacture referred to. The earliest was a machine patented by Andrew Smith, specially designed for the purpose. Enderby Brothers, of East Greenwich, made the first practical experiments with Phormium-tenax for Capt. George Harris, R.N. Very large works were established at Great Grimsby with the special object of manufacturing the Phormium-tenax into ropes, &c., and a large flax, mill was employed in making up the material into various woven fabrics. Look at the printed copy of Andrew Smith's specification, which you may easily do by going to the Free Library and asking for the "Alphabetical Index of Patents under the Old Law," and then inquire for the printed specification. The Society of Arts, some eighteen to twenty years ago, published a description of some material parts of the operation of preparing Phormium-tenax for the subsequent operations of scutching and hatchelling, or hackling. We will forward other details shortly.
Other Correspondents whose addresses we have will be written to by post.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we purpose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar and intelligible shape.—Ed.

The Smoke Prevention Act.—A shipbuilder, occupying extensive premises near the Commercial Docks, Rotherhithe, was (on the 17th Sept. ult.) summoned to the Greenwich Police Court, at the instance of the Government, and charged with non-compliance with the provisions of the Smoke Act. An engineer in the employ of the authorities gave evidence that he visited the premises on the 4th of August last, and found a dense smoke issuing from a furnace, connected with which were a steam engine and boiler, but no apparatus for the consumption of the smoke. There were also nineteen other furnaces on the premises without flues, and when all the furnaces were charged the place resembled a house on fire. The defendant's foreman expressed a willingness to undertake that the furnace of which complaint had been made, should not be again used until proper apparatus was applied. The magistrate (Mr. Traill), however, declared such an undertaking to be insufficient, and inflicted the full penalty of £5, adding, that this fine would be doubled on a second conviction. A stonemason, at Rotherhithe, was also summoned for a like offence, which being proved by Mr. Thompson, Government engineer, Mr. Traill inflicted a fine of £5, and 2s. costs.

Stealing Gas Burners.—At the Middlesex Sessions (September 9th ult.) a workman was indicted for having stolen six gaslights, the property of Her Majesty's Commissioner of Works and Buildings, from the new bridge from Battersea to Chelsea. The indictment charged that the offence was committed in the parish of Battersea, in the county of Middlesex. On discovery of the error, "Surrey" was allowed to be substituted for "Middlesex," whereupon a legal objection was raised by the prisoner's counsel, that the Court had no power to try the case, as it had no jurisdiction in Surrey. But it having been decided, on reference to precedents, that the Court had jurisdiction to try for an offence committed within 500 yards of the boundary of a county, and it being proved by a witness that the spot where the burners were taken from was less than that distance from the Middlesex side of the bridge, the case proceeded, and the accused (who had been employed on the works, and who bore otherwise a good character) was sentenced to three weeks' hard labour.

Fences to Quarries, &c.—In the Stroud County Court a curious case has been decided. The owner of a blind horse, which fell into a quarry on Selsey Common and was killed, brought an action to recover its value against the road surveyor, who, some ten or twelve years ago, had opened this quarry to get stone for mending the road, and had not subsequently filled it up or fenced it in, as required by Act of Parliament. Judgment was given against the surveyor for £5, the horse having been bought last year for £4 10s.

Crossing Railway Lines.—The frequent occurrence of accidents arising either from official neglect, defective railway arrangements, or the ignorance or wilful obstinacy of the public on this score, calls loudly for some more efficient system of prevention. We have elsewhere recorded a fatal instance wherein even a station-master has been the victim. Magisterial interference has, indeed, been resorted to in two recent instances; but something more effectual is, we apprehend, required. The Coroner's Jury, on an inquest held recently at Kingston on a man who was killed, or as the report has it, "cut in pieces by the up-train, whilst incautiously attempting to cross from one side of the Kingston station, on the South-Western Railway, to the other, while the up-train from Woking was passing," annexed to their verdict of "Accidental Death" a recommendation that when two trains met at a station, a porter should be placed to warn persons against crossing the line.

In another instance, at the Southwark Police Court (23rd Sept. ult.) a person was charged with attempting to cross the rails of the Brighton Railway terminus, London-bridge, while a train was in motion, and also with assaulting one of the Company's servants in the execution of his duty. An officer in the employ of the London, Brighton, and South-Coast Railway Company, was on duty at a barrier inside the terminus, where the public passed to proceed to the train. At 9 p.m. the bell rang, and he received a signal to start the train for West Croydon. He did so, and as soon as the train had started, the defendant came to him, and wanted to pass him. He told him it was too late, as the train had started. The accused then endeavoured to climb over the barrier, and afterwards he got over the wall, and went over to the arrival side, where a train was coming in from Brighton. The accused then jumped on the metals, and was about to cross over to the down Croydon train, which was then leaving the terminus, when one of the ticket-collectors rushed after him and stopped him, whereupon ensued the alleged assault. The defendant admitted crossing the metals, but denied the assault. The Magistrate (Mr. Burcham) was inclined to overlook the alleged assault, and to consider that he only pushed the officer while he was preventing him from serious accident to life or limb: he would, therefore, not inflict the full extent of punishment the law allowed him. As a caution, however, to him and others he (defendant) must pay a penalty of 40s.

Overcrowding Steamers.—At the Justice of Peace Court, Glasgow, 13th Sept. ult., the master of the steamer *Thistle* was charged with a contravention of the Merchant Shipping Act of 1854, sec. 319, for having on board, on his voyage from Londonderry to Glasgow, and on arrival in the Clyde, 1,700 passengers, being 1,174 more than the number allowed to be carried in said ship by the seagoing certificate issued by the Board of Trade—namely, 468 deck and 58 cabin passengers. Defendant had thereby incurred a penalty not exceeding £20, and also an additional penalty, not exceeding 5s., for every passenger on board over and above the number allowed by the certificate. The prosecution was instituted by the Board of Trade. The defendant was convicted, and sentenced to pay a fine of 1s. for every passenger in excess of the number allowed by the certificate, being £58 14s., and £10 (being half of the penalty of £20) in terms of the Act, making in all £68 14s., "the Justices trusting that this would prove a warning to the masters of river boats."

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Raising Sunken Vessels at Sebastopol.—Letters from St. Petersburgh state that notwithstanding reports published to the contrary, the Russian Engineers have succeeded in raising the ship of the line *Jagudil*, with the exception of the keel. The schooner *Smialaja*, of 16 guns, was likewise raised entire, and also the steamer *Turok*, taken from the Turks—the latter in such a good state of preservation that it is already repaired and doing service. The *Grunnuiji* and the *Duno* have likewise been raised.

Horse-shoes by Machinery.—A machine has been patented in America for making horse-shoes. It is capable of turning out 240 shoes an hour. No manual labor, beyond putting the iron into an oven, is needed. The molten metal flows thence into the machine, producing a web-formed horse-shoe, complete in every respect, even to the nail holes. The price is little more than that of bar iron. They are shortly to be introduced into this country.

The New Jacquard Loom of M. Vincenzi has been adopted on a large scale at Lyons, Paris, and elsewhere, and its inventor has received the honorary medal of the Parisian Academy of Arts and Manufactures. The chief improvement is the substitution of paper for cardboard, affording a reduction in volume of 60 per cent., and increased facility in piercing the design, inasmuch as the paper being much thinner than the cardboard hitherto employed, several sheets may be pierced at once; the tools, moreover, being considerably lighter, there is a great saving of labor to the workman. In cost there is a saving of 50 per cent. A Jacquard 400-card is 32 millimetres in length, whilst a Vincenzi 400-card is but 12 millimetres—a saving of two-thirds. A 1,200 Vincenzi-loom occupies no more space than does a 400 Jacquard one on the old system. There is also a great improvement in the action of the needles, which, in the new system, act horizontally, and without the concussion on the non-perforated portions of the pattern inseparable from the old method. The report states that this new invention is likely to operate a complete revolution in the weaving trade.

Thames Tunnel.—The amount of tolls for the week ending August 21, 1858 (for 13,322 passengers) amounted to £55 10s. 2d.

Poisonous Colors—Copper.—Dr. Pietra Santa, at the last sitting of the French Academy of Sciences, stated, in speaking of the pigment called "Schweinfurt Green," which is obtained by dissolving arsenious acid and the acetate of copper together, that the workmen engaged in its manufacture are subject to a peculiar affection, which produces pustules and ulcerations on the hands and feet; but that this affection is not dangerous, and may be conquered by lotions with salt water and the external application of calomel.

Water Shoes.—At Amsterdam there has been a regatta of young men who *walk the water* in shoes called *podoschapes*. One performer (Herr Ochsner) has accomplished the feat of walking up the Rhine, from Rotterdam to Cologne, in six days.

Lighting from Ceilings.—A new (?) Venetian method of lighting theatres is spoken of. By parabolic mirrors, the light is concentrated over an opening in the ceiling, and reflected down on a system of plano-concave lenses, a foot in diameter, which occupy the aperture, and convey the (divergent) rays of light into the theatre.

Homogeneous Metal Plates.—Some experimental steam-boilers, manufactured from these plates, recently invented, have been turned out at Woolwich; and after a succession of trials, the Lords of the Admiralty, finding that the present plates are not capable of resisting the amount of steam power required for the experiments, but desirous of profiting by the introduction of a less weighty material for the manufacture of ships' boilers, have ordered the inventor to supply plates of greater thickness and durability, for the purpose of carrying out a further course of trials.

Improvement in Lithography.—M. Paul Gauchi has succeeded in transferring *chalk drawings* from paper to stone, so as to yield any required number of impressions, a result hitherto attainable only in writing or drawing with lithographic ink. By the new process, impressions can be taken either in printing ink (as usual) or, if desired, in *black lead*, so as to have the effect of an ordinary pencil drawing. The specimens already produced are said to be absolutely deceptive.

RAILWAYS, &c.

Metropolitan Railways.—The nine great railways immediately connected with the metropolis have raised an aggregate capital of nearly 114 millions sterling, of which they have actually expended upwards of 112 millions. The proportion borne by the aggregate of traffic-receipts to the aggregate of capital expended is under 4 per cent.; and the average profits obtained by the original shareholders in these concerns (confessedly of the highest public utility) amount to only £1 12s. 6d. per cent., or thereabouts.

The North-London Railway's Locomotive and Carriage Works at Bow were, on the 26th August ult., destroyed by fire. These works, including the whole of the carriage-repairing shops on the ground floor; and the several workshops over, occupied a considerable space of ground on the east side of the incline, extending from the bridge which carries the Bow-road over the line to some distance down the Blackwall branch. The portion destroyed formed a long range of workshops, two floors in height, standing close to the up-line of rails, and comprising the carriage building and repairing depôt, turner's and painter's shops, and engineer's and smith's stores, with machinery, patterns, &c.: a number of carriages in the lower floor fell a sacrifice. The entire range of buildings was in one body of flame, as were also the boiler and engine-houses. The walls of the

destroyed building fell over on to the main line, and for a time impeded the traffic. Cause unknown. Owing to the telegraph offices at the station being closed (!), the police were unable to communicate to the London fire-stations; bence a considerable delay ensued in the arrival of engines.

Accident at a "Cutting."—A fall of earth occurred recently at Llanllwch cutting, where 83 navvies are employed obtaining ballast for repairing the South Wales Railway, near Haverfordwest. Several tons of earth suddenly fell off the embankment, completely covering two of the men beneath. By the timely aid of their fellow workmen, the *debris* were promptly removed; aud after the lapse of about a minute, one of the sufferers was extricated; but the other, who was further in, cutting under the embankment, remained buried for at least three or four minutes before he was liberated from his fearful position. Both escaped without fatal injury.

An Isle of Wight Railway to connect Ryde, Newport, Sandown, Shankling, and Ventnor, is on foot.

Great Russian Railway.—A new additional line is in contemplation between the town of Klimow, on the Volga, and Kalatschew, on the Don. Steamboats are intended to ply on the two rivers. In Transcaucasia a railway is also projected from Kutais to Tiflis.

Caledonian Line.—The works on the Granton branch are being proceeded with under contract, at the joint expense of the Duke of Buccleuch and the Company. The Holytown tunnel is being rapidly completed, as is also the Gartcosh branch.

Colne Valley and Halstead.—Three miles of the heaviest portion of the earthworks are completed, ballast laid for permanent way, and rails and sleepers delivered for four miles. By the spring the line will probably be completed to Bluebridge.

French Railways.—A preliminary trial-trip has been made on the section just completed of the Toulon railway (from Marseilles to Aubagne). In a few days it is expected this portion will be opened for traffic.

Toulon to Nice.—Peremptory orders have been received to expedite the works on this section without delay. For some days past an unusual degree of bustle has been observable on this line. The first portion to be finished is from St. Laurent to Lesterel.

Ardennes.—The section from Rêthel to Charleville-Mézières (on the Ardennes line) is completed, and will be opened forthwith. The works between Sedan and Givet, on the same line, are progressing rapidly.

A Runaway Engine.—A somewhat strange accident occurred (4th September ult.) on the Parr Branch of the North Western Railway. An engine called the "Hero" had a slight collision on the same line of rails with the coal-train engine "Goliath," the respective drivers and stokers of which, foreseeing the coming danger, had jumped off. The engine "Hero," before the driver and stoker could regain their places, bounded off at full speed, ran past the points at the junction of the branch, where the pointsman endeavoured to throw it off the line, and rushed at full speed to the terminus at the junction, where it broke down the railings, ran across the road, and knocked down the middle part of the station belonging to the London and North Western Railway, before its progress was arrested. A boy, who it appears had previously got unperceived on one of the buffers behind the engine, was killed. The station master at the junction, his mother, and three children who were in bed in the house at the time it was struck, escaped unhurt, the centre of the house only being demolished.

Prussian Railways.—An official return states that there are five Government railways in Prussia, besides seven under Government management, and fourteen belonging to private companies. Length of the whole, 294½ German miles (about 1,376 English), and their cost has been 255,204,526 thalers (£36,460,000).

Spanish Railways.—The inauguration of the line from Cordova to Seville is positively fixed for next April, so that the ceremony may coincide with those of the Holy Week at Seville. The Queen has promised to be present.

Accident on the Santander (Spanish) Railway.—The Directors were recently making a trial-trip on this line, when an embankment gave way, and the engine and tender of the train were thrown off, rolling over twice before they reached the bottom. About twenty persons were injured, and Mr. A. Jee, one of the engineers of the line, was killed instantly. The Madrid Journals received 20th September ult. state that his brother, Mr. Morland Jee, one of the sufferers by the same accident, died in consequence, some days back, at Los Corrales, a village near Santander.

The Traffic Returns on the Spanish Lines show an *increase*, as compared with last year, of 137,615 francs; as compared with last week, an increase (on passengers) of 1,017 francs; and on goods a *decrease* of 20,992 francs.

The City of Saragossa is occupied with the question of joining by a branch the Navarre Railway with that from Madrid to Saragossa. A commission of two members has been appointed by the Ayuntamiento, for the purpose of coming to an alternative understanding with the Ministry and the two companies, to arrange either for the Navarre Line to reach Saragossa, or that the junction shall be made near the Casetas, and not at Alergon.

The (Austrian) "Orient-Bahn," or "Eastern of the Emperor Francis Joseph," have published their general report, from which it appears that for the present they will confine themselves to the completion of 157 German *milles*, comprising the three first groups of their Imperial Grant, which (dated 4th March, 1857,) included :—1. A line from Vienna, by Oedenburg and Gross-Kanisa, towards Esseg. 2. From Neu Szony, through Stuhlweissenberg, towards Esseg. 3. From Ofen, by Gross-Kaniza, to the State-Southern Railway. 4. A line from Esseg to Semlin. The Directors state, that in October, 1857, they had been in treaty with two first-rate English firms for the supply of 650,000 cwt. of rails for these lines — that the coincidence of the war in India, and of the commercial crisis, enabled them to obtain these rails at the "extraordinary" price of 6 florins 30 kr. per cwt., delivered at their depôts in Pragenhof and Ofen. "Thanks to this coincidence," they add, "we have been enabled to make a saving on these rails of 2,000,000 florins, compared with what we should have had to pay for them in ordinary times."

Irish Railways—Belfast and County Down.—The last half-yearly report shows a small increase in receipts (to 31st July, 1858,) over those of the preceding year. A further increase is looked forward to after the opening of the Extension line to Ballynahinch and Downpatrick. As to the line in Scotland from Dumfries to Castle Douglas, it was rapidly advancing to completion, and the works from Castle Douglas to Portpatrick had been commenced.

Australian Lines—Geelong and Melbourne.—The Colonial Government have officially (12th July ult.) declined to purchase this line upon the terms of the Company's offer, on the ground (*inter alia*) "that the proposed terms are in excess of those proposed in December last."

First Railway Accident in Australia.—The "Times" correspondent from Sydney (July 10th ult.) states that the first serious railway accident occurred on that day. The train got off the line between Sydney and Paramatta, and the carriage toppled over the embankment. Only two persons were killed—several others severely wounded. The permanent way on that portion of the line had been long condemned as unsatisfactory. It was the first specimen of colonial railway making, and the Barlow's rails used had proved altogether too weak to sustain the traffic.

Ballarat Line.—The lowest tenderers for this line of railway having failed to pay their deposit, the local Government have fallen back on the next lowest tender, that of Evans, Merry and Co., only £1,600 higher. They have paid in their deposit, and were to proceed forthwith.

The Victor-Emmanuel Railway.—In consequence of the opening of the bridge of Culoz over the Rhone, and of the sections of the Lyons to Geneva and Victor-Emmanuel Railways, which unite at the bridge, a saving of five hours will be made in travelling from Paris to Turin and Milan.

Graissesac and Beziers.—The section of this railway (between Beziers and Bedarieux) 25 miles long, is to be opened to the public by the end of October inst.; a trial trip having been made on it by the Prefect of the Herault and the Government Engineers.

St. Denis to Creil, by Gonesse and Chantilly. This line will be opened in a few days.

The Ceylon Railway has been commenced. The ceremony of cutting the first sod was performed (August 3rd ult.) by the Governor, in the presence of about 8,000 persons.

Railway Accidents.—During the half-year ended the 30th of June last, 143 persons were killed, and 175 injured, from all causes, on the railways of the United Kingdom: 10 passengers were killed and 97 injured from causes beyond their own control; while 10 were killed and 12 injured owing to misconduct or want of caution; 8 servants of companies were killed and 33 injured from causes beyond their own control; while 65 were killed and 24 injured owing to misconduct or want of caution. There were 3 cases of suicide.

Austrian Railroads.—The Austrian Government will cede to the Lombardo-Venetian Railway Company the Vienna-Trieste Railway, as also the lines from Verona to Botzen, and from Inspruck to Kufstein (together 130 miles), and which cost the State about 80,000,000 florins, for £5,700,000; the Company, however, undertaking to construct three new lines—namely, 1. The line over the Brenner Pass, from Inspruck to Botzen; 2. A branch from the Trieste line to Agram and Sissek, in Croatia; 3. A branch from the Trieste line to Klagenfurt and Villart, in Carinthia.

Coal for Coke in Railway Locomotives.—The Directors of the Lancashire and Yorkshire and East Lancashire Companies have recently made some trial trips on the railways between Manchester and Blackpool, in order to test, practically, the merits of two inventions (of Mr. Jenkins and Mr. Lees, the respective locomotive superintendents of the two companies), by which they propose to secure the advantages hitherto greatly desired of substituting coal in the place of coke for locomotive purposes, one essential being that the smoke shall be consumed in the fire-box itself—this being, in fact, the main obstacle to be overcome. The trial train was composed of fifteen waggons, loaded with old metal, two first-class carriages, and two brake vans. Length of train, 240 yards; estimated weight, 271 tons 15 cwt., including engine and tender, which, when filled with coal and water, would be 41 tons 8 cwt. The journey from Salford Station to Bolton, 10 miles, with a rather heavy ascent, took 35 minutes; from Bolton to Preston (20 miles), 43 minutes; the remaining 18 miles, 68 minutes. The return journey, from various accidental and local obstructions, occupied rather more time. The results of the trip, however, are stated to have been most satisfactory, the total consumption of coal being only about 39 cwt. for the whole journey. The coal used was that of the Ince Hall Company, at Wigan, costing 5s. 3d. per ton. Cost of the trip, about 10s. 3d. With coke, which costs about 11s. to 11s. 6d. per ton, the expense would have exceeded (for same journey, as previously ascertained by experiment) 20s. As regards the prevention of smoke, the result of the experiments is stated to have been equally favourable.

Crossing Rails—A Station Master Killed.—Derby, September, 22nd ult. At the Sawley station, on the Midland railway, about six miles from Derby, Mr. Thomas Turner, the station master there, was seen to cross the line for the purpose of altering the semaphore-telegraph on the approach of a passenger train, and having arranged the signal, was retracing his steps, when another train came up, and he was struck by the engine, and hurled with great force into the middle of the rails: he was instantly killed. The train which knocked him down was a goods' one, and not due at any particular moment. [We confess we do not quite understand the concluding words of this statement, "not due at any particular moment"—nor do we clearly see of what practical use as a preventive of danger can any system of timing or telegraphing be, where such erratic licence is allowed to a "goods" or any other train whatever.]

TELEGRAPH ENGINEERING, &c.

A Telegraphic Congress, in which France, Belgium, Holland, Sardinia, Portugal Baden, Wurtemberg, and Switzerland, are represented, has just been opened at Berne, under the presidency of M. Naeff, Federal Councillor.

Telegraphing Music.—An application of electricity, the feasibility of which has occasionally been hinted at, but as yet, we believe, not practically tried in this country, has recently, according to the "Emancipation" of Brussels, been made by a Hungarian, M. Léon Hamar, who, in a public concert at the National Theatre, has played, by means of electric wires, on five different pianos at the same time. The electric battery which worked the wires was in an adjacent room. *Time*, as we all know, has already been successfully telegraphed, and we, for our part, have never entertained a doubt as to the possibility of bringing *music* under similar control. The main difficulty resolved itself into a mere question of practical detail, which, if the truth of the announcement in the foreign journal quoted may be relied on, has now been solved.

Electric Telegraph Company in Ireland.—On the 26th August ult., with the approval of the Court of Chancery, the whole of the line, plant, and materials, of this company were put up for public sale, at the Auction Mart in London. The company was established in 1853 by Act of Parliament. The line was originally intended to reach from Dublin to Donaghadee, on the coast of Ireland, and thence continued by submarine cable to Port Patrick, in Scotland, to a point near Dumfries; thus establishing a complete line of telegraphic communication between Dublin and London. The line from Dublin, through Belfast to Newtownards (qy. Newtonwards), a distance of 117 miles, is completed and ready for business. In Scotland, the line has been laid down from Dumfries to near Port Patrick, about 79 miles. The only offer made (£500) being much below the reserved price fixed by the Court of Chancery, no sale was effected.

The Indemnity to Professor Morse, for the usage of his electrical-telegraph apparatus, is, it appears, not yet definitively settled, the Representatives of the European Powers having originally awarded him 400,000 francs (£16,000), of which France was to pay 235,000 francs, Sardinia 15,000 francs, Rome 5,000 francs, &c. The money to be paid in four instalments. It is now, however, stated that some considerable reduction has been made in the amount first awarded.

The Newfoundland Telegraph.—The length of the telegraph line from Boston, U.S., to Trinity Bay, Newfoundland, is about 1,600 miles, nearly the length of the Atlantic Cable. The line traverses Maine and New Brunswick, going round the head of the Bay of Fundy; it then takes the northern shore of Nova Scotia, and crosses the Gut of Canso. Here is the first section of submarine telegraph; it is only 2½ miles in length, and serves as the connection between Nova Scotia and Cape Breton, touching the western coast of that island. From the western to the eastern shore at Aspy Bay is a wide space of territory, where the telegraph stations are few and far between. At Ashby Bay commences the second submarine line; it is 76 miles long, and connects Cape Breton with Newfoundland. The cable is quite large, composed of three strands, and has three conducting-wires. From Port-au-Basque, the cable-station on the western part of Newfoundland, the telegraph extends directly across the island to Trinity Bay, about 400 miles, through a wild country, for the most part unbroken forest, where the trees had to be cut down to make room for the telegraph-posts. There are five stations along the whole distance, the territory of which is sparely inhabited. This telegraph line is owned by three different companies—the American Telegraph, the Provincial, and the Newfoundland and London Telegraph Companies.

England and the Hague.—The great cable now being constructed for this telegraph line at Glass and Elliott's, for the Electric and International Telegraph Company,

is the largest and heaviest cable that has yet been manufactured. Up to the present time, electrical communication between this country and the Hague has been maintained by, comparatively, light ropes, four in number, each containing one copper conductor, and each covered with solid iron wire. Vessels navigating between Lowestoft and Holland were almost constantly injuring these cables, so that it was necessary to keep a steamer specially employed to pick them up, mend them, and lay them down again. To obviate these difficulties, the present "monster rope" has been constructed, combining the four wires in one, and otherwise of such strength and weight that, if a vessel is so unfortunate as to catch her anchor in it, she will (such, at least, is the opinion of the manufacturers) infallibly lose it, as beyond a doubt she can neither raise nor break this cable.

Ceylon.—Recent advices from Colombo state that the electric telegraph is open as far as Kandy, and will reach Manaar by the end of October. The cable which is to connect Ceylon with India, and to make Galle the port of call for vessels engaged in the Indian trade, was already laid at the Paumben Straits, and ready to be carried across them so soon as the weather would permit.

The Honour of Knighthood has, by the Lord Lieutenant of Ireland, been conferred on Mr. (now Sir Charles) Bright, as chief engineer of the Atlantic Telegraph operations.

The Adelaide and Melbourne Electric Telegraph was to have been opened throughout on September 1st, the delay in doing so having been occasioned by damage done to the submarine cable at the mouth of the Murray river.

A Banquet, in honour of Mr. Bright, as Chief Engineer of the Atlantic Telegraph, and to celebrate the laying of the cable, was given (1st September ult.) by the Lord Mayor of Dublin, at the Mansion House. Cardinal Wiseman ("Archbishop of Westminster," as the "Freeman's Journal" will have it) was present at the banquet; but the invitation given to the Lord Lieutenant (Lord Eglinton), the Chancellor, the Lord Justice of Appeal, and other public functionaries, was (pointedly, it appears, and for that very reason) declined by them. A piece of the Atlantic Cable, neatly bound up with brass ferules, was laid on the tables beside the plate of each guest, to whom it was presented as an appropriate *souvenir* of the interesting festivity. On a small brass label fastened round each specimen was the inscription, "Part of the Atlantic Cable, manufactured by Messrs. Glass, Elliott, and Co."

Over-House Telegraphs.—A new method of Electric Telegraph communication has been practically tried in London, and, we believe, with success. Mr. Sydney Waterlow, stationer, having establishments in Parliament-street, Birchin-lane, and London-wall, has connected them by an over-house telegraph. For the whole distance, 4,871 yards of wire were used. The telegraph wire is carried in one stretch from London-wall to Birchin-lane, thence to Cannon-street, Calvert's Brewery, Red Lion wharf, Maidstone wharf, Trigg wharf, the City Flour Mills, White's Iron wharf, the Shot Tower, Goding's Brewery, Maudslay's Boiler factory, and finally crossing the river to Parliament-street. The wire is of steel, and so fine that foot-passengers can scarcely see it. The telegraph has cost about £50 per mile. It is said to be in contemplation to connect, in similar manner, all the Fire Brigade and Police Stations in London.

Another Grand Banquet, to celebrate the laying of the Atlantic Cable, was given on the 7th September ult., in Killarney, to the Chairman and Directors. The entertainment in this case was honoured by the presence of the Lord Lieutenant (Lord Eglinton).

The Prussian Minister of Commerce has just founded a special school for forming clerks for the Electric Telegraph offices.

Atlantic Cable.—A notice to the "Times," signed by the Secretary of the Atlantic Telegraph Company, dated September 4th ult., states that owing to some cause not then ascertained, but believed to arise from a fault existing in the cable at a point hitherto undiscovered, there had been no intelligible signals from Newfoundland since 1 o'clock on Friday morning preceding; that the Directors were then at Valentia, and, aided by various scientific and practical electricians, were investigating the cause of the stoppage.

Jersey and England.—The Submarine Telegraph between Jersey and this country was opened to the public on the 7th September ult. Messages had passed. The cable starts from Church Bay, Portland, and rests in depths of water varying from 35 to 40 fathoms, as far as the Island of Alderney, which has been fixed upon as the first station; thence it stretches to a point on the north-west coast of Guernsey, and crosses the Island to St. Peter's Fort, where there is a station in the guard-house nearly upon a level with the sea. It then runs to Cape Gros Nez, and is landed upon a sandy beach. Eight or nine miles of underground work bring the line to St. Helen's. The station is at the corner of the Grand-square. The opening of "the Channel Islands Telegraph" was inaugurated by a message from Mr. Aubin, Constable of the Island of Jersey, to the Queen; and Her Majesty returned a suitable reply from Holyrood Palace, Tuesday night, September 7.

Hemp for Marine Telegraph Cables.—Mr. Rowett, of Leadenhall Street, proposes a hempen cable of his invention, as preferable (so he alleges), for various reasons, to one of iron for deep-sea telegraph purposes. The sample of hemp cable he has exhibited (18th September ult.) weighs about half a ton to the mile, and the paying-out strain upon it would be at the rate of about 25 lbs. to the mile. His cable is to be submitted to a mineral preparation that enters into chemical combination with the fibres of the hemp, so as to render it impervious to sea water, and protect it from the action of animalcules and other destructive influences. Its cost would be £86 per mile.

English and Dutch Telegraph.— The *W. Cory* screw steamship, accompanied by the *Reliance* steam tug, left Greenwich (September 20th ult.), with the submarine cable to be laid down between Dunwich, on the Suffolk coast, and Zandwoort, on the coast of Holland. This cable is the largest yet manufactured, is 140 miles in length, weighs nearly 1,400 tons, is ten times as heavy per mile as the Atlantic, and contains four conducting wires. Manufacturers, Messrs. Glass, Elliott and Co., who are executing the works for the Electric and International Telegraph Company.

Electric Telegraphs.—The question of priority of discovery as regards the electric telegraph has lately given rise to much difference of opinion. The "Cosmos," a French scientific journal, claims for Mr. Wheatstone the merit of originality. With the American journalists the palm is contested as between Mr. Morse and Dr. Jackson, of Boston, the celebrated inventor of etherification. In all these discussions, it seems to us that the merits of a far more legitimate claimant are entirely overlooked, namely, those of Dr. Franklin.

Italian Telegraphs.—The "Triest Zeitung" learns from Turin that there is a lawsuit pending between the Spezzia-Cagliari Telegraph Company and Mr. Brett. The Company demands from the engineer 1,600,000 francs, as an indemnification for the loss it sustained by the two unsuccessful attempts to lay the cable, and Mr. Brett claims from the Company a further payment of 400,000 francs. The process is likely to be a lengthy one, as both parties are armed with memorials.

Nothing decisive has yet transpired as to the real cause of the failure of the Atlantic Cable. The result of tests recently made at Valentia would seem to indicate that the defect is owing to a loss of insulation at about 220 statute miles from the shore. The cable is supposed to have been injured by being too rapidly let out "when crossing the submarine mountain range which divides the depths of the Atlantic from the comparatively shallow water nearer the Irish Coast." Hopes, however, are still entertained of the possibility of remedying the defect.

A Telegraphic Map of Europe has been published. It is printed from a composition of common printing types, quadrats (formed each of 16 nonpareil squares), points, and bent brass rules, in combination with a process of tracing, or transfer, the invention of M. Mahlau, of Berlin.

MARINE STEAM ENGINEERING, SHIPBUILDING, &c.

Wreck of a Screw Steamer.—The *War Eagle* steamer (on the 24th August ult.) landed at West Hartlepool the master, mate, engineer, and entire crew, of the London screw steamer *Times*, which vessel was totally lost, with a deck-load of cattle and other freight, from Harlingen for Newcastle (22nd August ult.), off the North-Yorkshire coast, Huntcliffe Rock, about 30 miles distant W.S.W. The engine-shaft suddenly broke, the stern-post gave way, and with it an extensive breach was made through the whole of the after-part of the ship. At 8 p.m. the steamer went down, the crew, &c. (15 in number) taking to their boats and ultimately, after various mishaps, falling in with the *War Eagle*.

The "Trafalgar" 120, is undergoing alterations, in Chatham Dock, to convert her into a 91-gun screw-steamer. She will be furnished with machinery of 1,000 H.P.

The Launch of the "Windsor Castle," screw line of battle-ship, came off successfully at Pembroke on the 26th ult., in the presence of Sir John Pakington and the other Lords of the Admiralty, who were on their annual tour of inspection. The *Windsor Castle* (formerly the *Victoria*) was commenced in 1844, and has recently been altered to receive the steam-screw. Her dimensions and armament are:—Length over all, 240 ft.; burden in tons, 3,099; guns, 100. Engine-room to contain 400 tons of coal.

Steam Postal Communication with Australia, *vià* the Panama route.—A deputation of London bankers, merchants, &c., waited, by appointment (30th August ult.), on Sir E. B. Lytton, at the Colonial Office, with a memorial in favor of the establishment of a new mail route by way of Panama; the Governments of New South Wales and of New Zealand having already voted unanimously—the former £35,000 a year, the latter £15,000 for that object. The Colonial Secretary's reply was favourable, but not conclusive, as the decision on such subjects rested with the Treasury.

Towing Steamers are to be established in the Straits of Magellan to assist ships in passing through there, which will shorten the distance from Europe to Chili by 1,500 miles.

The Lever-Line (Galway to America) is regarded with confidence in New York as being now perfectly established. The steamer *Prince Albert* arrived 1st September ult., at Galway, having achieved her passage thither from Halifax in 7 days 23½ hours, and from New York (21st August ult.) to Galway in 9 days 22½ hours mean time, including stoppage at Halifax by heavy fogs. Cargo, 1,007 tons dead weight. Passengers, 251. Steamed the whole way without aid of canvas.

The "Messenger" Anchor-Shackle.—A new (American) invention under this designation has been recently submitted to the Committee of "Lloyd's," to the General Shipowners' Association, &c., in this country. It is stated to be a preventive of the constantly recurring disaster of ships going ashore; and by its means the captain of a vessel may, in time of danger, place out a second anchor on either or both riding chains, with great dispatch, and at any desired point; it will also facilitate a ship's riding with greater safety in open roadsteads. The patentee is Captain Gilmour, of Boston. The invention, it appears, has been adopted by the naval authorities of the United States, and in the mercantile marine of America, after practical proof of its efficiency. One of the test-experiments took place on board a powerful steamer, when an anchor being let go, and a good scope of cable payed out, it could be run away with readily, with one paddle-wheel going. An auxiliary anchor was then put on the same chain by means of the "Messenger-Shackle," let go, and allowed to run about 10 fathoms short of the first anchor, when the vessel was brought up, and with three times the power of steam put on, and with both paddle-wheels going, *she could not be moved at all*—thus showing the efficacy of the new invention. Amongst other names given as approving of the new "anchor-shackle," are those of Capts. Harrison, of the *Leviathan*, Guthrie, of the Peninsular and Oriental Company, and Trotman, inventor of the well-known anchor bearing his name.

The Russian War Steamers.—It is stated in "Galignani's Messenger" that Russia, ever since the conclusion of peace, has been building at Nicolaieff (on the Black Sea), not only vessels of commerce, but also large vessels of war, one of which, a screw ship of the line of 131 guns, the *Sinope*, is now (September) about to be launched. That, in addition, three screw corvettes are being built there for the Black Sea Fleet, and contracts for the supply of large quantities of iron [? from England—Ed.] for the fleet are about to be entered into.

Jointed-Steamers.—A vessel of a new and peculiar construction (the jointed screw-collier "Connector," from Newcastle to London and back) has been tried, we understand, with success. The invention, which is spoken of as likely to produce a great change in the coasting, and more especially in the coal-carrying trade, is founded on the possibility of applying to water navigation the principle of attaching a series of trucks or carriages to a single locomotive, but without liability to concussion. For this purpose the several sections of the vessel are not merely attached together, but fit into each other on the principle of the ball and socket, forming, in fact, a veritable jointed ship, accommodating itself to the action of every wave she meets, as though the keel were a vertebral column, jointed like the neck of a swan. As regards the coal-coasting trade, the new "jointed ship" purposes to do away with the necessity of re-shipping into barges by, so to speak, breaking itself into barges, on its arrival in the river, leaving a section wherever it may desirable, and obtaining its new freight (through its capability of thus dividing its presence) with the least possible delay.

The "Leviathan."—The French Emperor, it appears, is desirous of purchasing this huge vessel, for the purpose of converting it into one of the "vaisseaux-bélier," or "naval battering rams," we have elsewhere noticed. The bows would be reinforced by stupendous iron beams, or girders of immense size and strength, and sharpened so that she might cut down any ship with which she might come in collision. Thus armed, and propelled by a combined force of 2,000 H.P., and additional impetus of the winds on her canvass, she would bear down everything before her. Such, at least, is the sum of the speculations afloat on the subject. The price demanded is £600,000, about two-thirds of what the ship has cost.

A Line-of-Battle Screw Steamer, of 91 guns, is ordered to be laid down on the slip at Chatham Dock, from which the *Mersey*, 40-gun steam-frigate, was recently launched.

A New Screw Steam Corvette, to be called the *Stork*, is being laid down at No. 1 building slip at Sheerness. She is to carry 21 guns, of heavy calibre.

"Vaisseau-Belier," a battering-ship, or "vaisseau-masse," completely cased in iron, is now constructing at Cherbourg, under the direction of M. Joyeux, sub-engineer of naval constructions.

Life-Boats for Russia.—The Grand-Duke Constantine, High Admiral of Russia, has requested the Royal National Life-Boat Association to provide, at the expense of the Russian Government, life-boats on the society's plan for the coast of the Gulf of Finland.

Dundalk Life-boat.—Lord Clermont has liberally undertaken to build a house for the reception of the life-boat and carriage which the Royal National Life-boat Institution is about to station in the vicinity of the dangerous bay of Dundalk.

The Launch of the "Cologne," paddle-wheel steamship of the General Steam Navigation Company, designed by Mr. T. Smith, of the firm of Mewbon and Smith, Naval Architects, of Fenchurch Street, and built at London Yard, Isle of Dogs, took place at Millwall, on the 24th August ult. Length between perpendiculars, 190 ft.; breadth for tonnage, 23 ft. 6 in.; breadth on deck, 25 ft. 6 in.; depth in midships, 14 ft.; tonnage, B.M. 516 66-94ths; beam engines; 1 tubular boiler; H.P., 140; contents of bunkers, 30 tons; draught of water when loaded, 7 ft.; frames, L 3 by 3½ by ½ spaced, and 18 in. apart throughout; 11 strakes of plates from keel to gunwale. Intended for passenger and cattle-trade service between London and Rotterdam.

MILITARY ENGINEERING, &c.

THE "HORSEFALL GUN."—One of the largest guns in the Ordnance Service, which has remained for some time at Shoeburyness, and has sustained every description of experimental test, was (27th August ult.) shipped on board the Government lighter *Bomarsund*, Woolwich military store transport, to be forwarded to Portsmouth, where it will be placed in position on Southsea-common, as part of the system of coast defenees now being carried into effect by the authorities at the War Department. This gun, known as Mr. Horsefall's, and manufactured by the Mersey Steel and Iron Company, was presented by the former gentleman to the Government on the understanding that it should be employed "in defence of British rights." It is 17 ft. long, 11 ft. 3 in. in girth, and carried 13 in. solid shot, with an ascertained range of $3\frac{3}{4}$ miles. Charge of powder 70 lbs.

HEAVY GUNS, of long range, have also been placed in position, by the Royal Artillery, at Eastbourne, and at stations on the coast of Kent and Sussex; and several new batteries for similar service are now completing at Woolwich Arsenal.

A MILITARY "SPAN-BRIDGE" is being erected at Chatham, near the Creek, by the Royal Engineers.

THE ROYAL GUN FACTORIES, WOOLWICH, are, for the present, under the superintendence of the Captain-Instructor of Artillery, Captain Haultain, a temporary leave of absence having been granted to the Superintendent, Lieut.-Col. Eardley Wilmot.

LANCASTER RIFLE MUSKET *v.* ENFIELD RIFLE.—Further experiments to test the comparative merits of these weapons still continue to be made at Chatham. The result has been even more decisive in favor of the former than heretofore. The range, as in the former trials, extended from 350 to 600 yards. One marksman made twenty "points" out of twenty rounds (with the Lancaster rifle), the average practice being 15·88 L. "points," to 10·98 "points" E.

SEA DEFENCES.—The whole of the fortifications at Sheerness are to be reconstructed and fitted for working guns of the heaviest calibre, both for shot and shell. Tenders were officially notified to be sent in to the Director of Contracts, War Office, Pall-mall, on the 8th September.

WOOLWICH ARSENAL.—On the 30th August ult., Commodore Count Popoff, and a party of officers from the Russian Squadron at Portsmouth, visited Woolwich Arsenal, by permission of the War Department, and inspected the Royal Laboratory and other departments of that establishment.

SAFETY GUN-LOCKS.—An improved gun-lock, the invention of Captain Harris, has, after satisfactory trial, been adopted in the army. By order of the Duke of Cambridge, the Guards have been armed with 1,000 rifles with the improved lock, which is described as entirely doing away with the danger hitherto attendant upon the use of firearms, "combining, as it does, the required security, with an increased lightness of pull-off."

THE NEW RIFLE FIELD-BATTERY.—By this invention (introduced into military tactics by Brigadier-General Sir C. Shaw), six or eight men will, it is asserted, be enabled to throw on an enemy more deadly fire than will upwards of 300 soldiers under the present system. The machine (which, by the way, reminds us of the "Pacificator," so much talked of some years since, but now, it seems, sunk into oblivion) can be moved about the field of battle at the rate of 6 miles an hour, whilst soldiers can now change position only at the rate of 2 miles an hour. The new device is an horizontal arrangement of capped Enfield-rifle barrels, 24 in number. By means of a master-winch, the whole 24, placed at any given elevation, and in any lateral direction, may be discharged at once; or the barrels may be separately discharged, after the manner of platoon firing.

RIFLED CANNON—The "Débats," in a recent article on Cherbourg, states an important and, as it would appear, hitherto in this country, at least, unsuspected fact—namely, that "rifled cannon have become a 'regulation weapon' of the French navy." This statement has already elicited some interesting correspondence in the London press, from which we gather—1st. That "rifling" adds from 50 to 100 per cent. to the mere range of guns, but that in closing every yard increases the disparity of force, the initial velocity of projectiles being the greatest. The greater projectile force of rifled cannon, therefore, tells every way. 2nd. That, to show the difference of range, Capt. Dahlgren gives, from careful experiments, the range of 18-in. shells, weighing 51 lbs., at 5 deg., 1,770 yards. A similar experiment, made by Col. Mitchell, at Shoeburyness, in 1856, with solid shot 80 lbs. weight, *from a rifled gun*, showed the range to be nearly 2 600 yards at same elevation. 3rd. That to oppose ships carrying smooth-bored guns to others armed with rifled cannon would, therefore, be to expose the former to almost certain destruction. 4th. That the English press has been hitherto unaccountably unaware of the existence in France of rifled cannon, even after it had become a "regulation weapon" in the navy of that country. And 5th. That it can be officially proved that the English Government were acquainted with the invention of rifled cannon long before the French, but have failed to turn such knowledge to account.

SHOT-PROOF STEAM-RAMS.—By way of a set-off to the recently much-talked-of "*Vaisseau-Bélier*," said to be actually in process of construction at Cherbourg, Admiral G. R. Sartorius has renewed a proposal already made by him to the British Government during the late Russian war, for the building of vessels of war to run down the enemy's ships. The stem or stern (for each is either) of the "steam ram" is to be of the same form; and at each end a massive projecting prow or *rostrum* is to be fixed, by means of which the blow is to be given, the projection being sufficient to protect the rudder from injury, and the prow having shoulders to to prevent the possibility of its too deep insertion. A screw-propeller at each end is to double the means of propulsion, whether for backing, going a-head, or turning. Furnished with these and various other details of armament, both offensive and defensive, including a shot-proof construction of the hull, and two iron towers on deck, &c., the projector, and his supporters of the press, confidently anticipate for the new sea-monster the speedy annihilation of all hostile forthcomers, whether from the "peaceful-fold" of Cherbourg, or elsewhere.

GAS ENGINEERING—(HOME AND FOREIGN).

GAS EXPLOSION.—At Haggerston Independent Gas Factory, in the forenoon of the 9th September ult., a fearful explosion of gas took place, by which several persons were greatly injured, and five were dreadfully burnt. An escape of gas occurred from one of the great mains in the valve or regulating shed; it rushed out so fiercely, and in such quantity, that it entered the smiths' shop, where, coming in contact with the furnace, it ignited, and exploded with a noise resembling the discharge of a piece of ordnance. The two shops were wrapped in flames, and several of the workmen were much injured, more especially five of them, who being unable to rush out in time, became encircled in flame. The valve shop and smiths' shed, extending 40 ft. in length, were burnt out.

A MONSTER GASOMETER is being constructed by Messrs. Westwood and Wright, Engineers and Gasometer Builders, of Brierly Hill, Dudley, for the Imperial Gas Company, Hackney Road. The machinery for the execution of the work is of unusually large dimensions, on account of the ponderous weights required to be raised to a great elevation before they could be secured. In a few weeks this monster specimen of engineering will be completed.

ANOTHER GAS EXPLOSION occurred, about midnight, on the 14th September ult., at the town residence of Colonel Fulke Greville, M.P., Albert Gate, Knightsbridge, and was attended with very serious injury to several persons. The gas pipes being under repair there had been a considerable escape, and three of the female domestics being awakened by a strong smell of gas, proceeded down stairs to ascertain the cause. On entering the back parlour with a light, a terrific explosion took place, knocking them down, and scorching them so dreadfully that but slight hopes were entertained of their recovery.

A VILLAGE LIGHTED WITH PEAT GAS.—The "Dublin Freeman" announces the successful lighting of a village in Ireland (on the property of John Wilson, Esq., J.P., Daramona, Westmeath) by gas made from the peat of the bogs in the locality. The apparatus was erected under Mr. R. L. Johnson's patent. The accomplishment of this attempt to extract something good at last out of Irish bogs was, it seems, hailed with enthusiasm by the people, who had assembled (9th September ult.) to witness the ceremony of "striking a light" at the village works, "cheers, and every possible demonstration of gladness," being vented at the success of an undertaking so truly illustrative of Irish resources. The quality of peat-gas is described as being remarkably brilliant, and its production economical.

WATER SUPPLY—(METROPOLITAN AND PROVINCIAL).

THE LOCAL WATERWORKS in many places, more especially on the north-east coast, have wholly or partially failed, in consequence, it is supposed, of the unprecedented absence of rain-fall this season. At Berwick-upon-Tweed there has not been an available shower of rain from August, 1857, to August, 1858. The springs and local waterworks have run dry or short of water in consequence. The waterworks have also partially failed at Bolton, Liverpool, (the Pike) Manchester, and other places.

PUBLIC DRINKING FOUNTAINS FOR LONDON.—The Metropolis, it appears, is likely to follow the good example set by Liverpool and other provincial towns. Mr. Melly (Liverpool's public benefactor) has offered two granite fountains, with bronze heads and handles complete, for the City of London, provided any lady or gentleman will undertake to erect them, and procure a constant supply of water for the same. Efforts are likewise being made in other quarters to introduce public drinking fountains in the City of Westminster.

THE BOURN ARTESIAN WELL.—In boring for the waterworks of Bourn, in Lincolnshire, through different strata of earth, a remarkable spring has been found, which will, by its own natural force, throw the water 25 ft. above the earth's surface, emitting no less than 365 gallons per minute: probably, there is not another artesian well in this country, if in Europe (that of Grenelle, in Paris, perhaps, only excepted), which yields so large a supply of water for the size of the bore. The Company's engineer, who carefully guaged it in 1856, and checked its yield, certifies that the supply was 567,000 gallons per diem (of 24 hours), an enormous flow up a 4 in. pipe. At present this discovery affords the unusual instance of a town supplied with water constantly on, under "high-pressure," from a local natural reservoir—namely, a well, *without the aid of engines or pumps.*

RAILWAY STATION FOUNTAIN.—A director of the Midland Railway has erected, at his own expense, a marble drinking fountain on the Leicester Station.

OLDHAM NEW WATERWORKS.—The first stone of these new works, in the Piethorn Valley, about 7 miles from Oldham, has just been laid. It is intended to make three reservoirs; the first, at the top of the valley, to be fed principally by the Piethorn stream, which takes its rise on Bleakedgate Moor. The middle, or principal reservoir, will receive water by the Colsgreave stream. At the lower end of the valley an embankment will be thrown across to form the lower end of the reservoir. The embankment, in the centre of which will be a puddled wall, will contain 385,000 square yards, and the area of the reservoir will be upwards of 30 acres. The water will thence be conveyed into the town by a 20-in. pipe, and from the lower one by a 14-in. pipe, both pipes being placed in a culvert 6 ft. in diameter and 100 yards long, arched over with three separate courses of stone, running through the embankment, and terminating in a valve-house.

THE "HYDROSCOPE" (OR WATER-SEER).—One of those startling scientific incidents in modern days, by which we are involuntarily reminded of the pretensions to occult and mysterious knowledge—the transmutation, rod-divining, and other kindred professions of the "black art," characteristic of the middle or dark ages—is now claiming a considerable share of public curiosity and attention. We allude to the actual presence in England, and, we believe, in the metropolis, of M. Joseph Gautherot, the "hydroscope," or water-diviner, who has of late earned for himself so much celebrity, even in high official quarters, for his apparently marvellous faculty of discovering the existence of water in any locality wherein it may be deemed advisable to sink Artesian wells.

HARBOURS, DOCKS, CANALS, &c.

THE KENSINGTON CANAL, now belonging to the West London Railway Company, is likely to be disposed of to the London and North Western, the shareholders and Board of Directors of the former Company having appointed a Committee to consider of the propriety of disposing of the West London Railway, and all their other property (including the canal in question), and to report thereon to a meeting on the 26th October next. The Directors' report (West-London, 27th August ult.) states that a decrease had taken place in the traffic on the Kensington Canal, when compared with the corresponding half-year of 1857, of £266; and that the London and North Western Railway Company had expressed their willingness to treat for the purchase of the same.

NO. 4 DOCK IN PORTSMOUTH DOCKYARD is about to be lengthened 40 ft.

GALLE HARBOUR, CEYLON.—The survey of this harbour, which is to be made the port of call for vessels engaged in the Indian trade, is rapidly advancing.

PRESSURE ON DOCK-BEARING PILES.—At Hull Dock, the diameter of the bearing piles is 10 in., and the load 37 tons to the square foot, whilst at London-bridge, on 10-in. piles, the load is 80 tons. So is it 80 tons the square foot, with the same-sized piles, under the Albert Warehouse at Liverpool.

CHATHAM DOCK.—The large stone basin which has been for several years in course of construction at Chatham dockyard has been completed, and will shortly be ready for the reception of the largest line-of-battle ships in the service. This completes the first of the large stone docks which are to be formed here. It is very nearly 400 ft. in length from the extreme ends, and in breadth 92 ft. The foundations are laid on beds of concrete, and to a great depth, in order to guard against any sinking of the floors. The bottom and sides are of the best granite.

NEW AND EXTENSIVE DOCKS are, it is said, to be formed by a Company, between Rosherville and Northfleet, including the site of Rosherville Gardens.

THE MOUTHS OF THE DANUBE.—The International Commission appointed to examine the mouths of this river have reported decidedly in favour of the St. George's mouth as affording the most navigable channel, and the best communication with the Black Sea. Dredging and engineering operations will, it is understood, be speedily commenced, to improve the navigable capacity of this channel to the utmost.

CANAL COMPANIES.—The total share capital of canal companies in England, paid up on the 31st December last, was £13,053,696; and the dividends were respectively 3·72 and 3·28 on original and preferential shares. The total capital of canals in the United Kingdom, at the end of 1857, was £13,775,924.

PROPOSED NEW DOCKS IN CONNEXION WITH THE NORTH KENT RAILWAY.—It is stated, we have reason to believe on good authority, that the extensive building establishment of Mr. W. Pitcher, at Northfleet, which has been closed for some months, is to be appropriated for the construction of some of the largest floating-docks in England, with wharves and quays of great magnificence, extending to the cliffs, and to be joined by means of a tunnel to the North Kent Railway. The excavations for procuring ballast for shipping, carried on for many years past in the immediate neighbourhood of the premises, have rendered the site in question peculiarly fitted for the construction of a dock and basins. The idea is understood to have originated with a Mr. Tabberner, and the works are to be entrusted, it is said, to Sir Charles Fox, the eminent engineer, Mr. J. R. Crampton being the contractor. The spacious wharves and warehouses on the Middlesex side of the river, between London-bridge and the Tower, are to be bought, pulled down, and rebuilt as warehouses, in connexion with the proposed docks.

BRIDGES.

Charing Cross (Hungerford) Suspension Bridge.—The report to the half-yearly meeting states, that the tolls for the half-year ending 31st July amounted to £2,910, being a decrease on corresponding half-year in 1857 of £71, a falling off which the Chairman attributed to the impure state of the Thames in the hot months of June and July, "the filthy exhalations having deterred people from crossing the river." The ordinary expenditure in the maintenance of the bridge (for what period is not, in the report we quote from, clearly stated) amounted to £1,951.

The Aqueduct Bridge in course of construction on the Great Western and Brentford Railway is, according to the half-yearly report, nearly completed. The works had been somewhat delayed by a movement that had taken place in one of the wing-walls of this aqueduct bridge, as likewise of the dock-wall—contingencies, however, which had been provided for in the building contract, and which are now being remedied.

Sunderland Bridge.—The workmen employed on the works presented Robert Stephenson, Esq., M.P., and his brother engineers, with an address on the occasion of his recent visit to Sunderland, in company with the members of the Institution of Mechanical Engineers. A suitable reply, eulogistic of the improved skill and intelligence of the workmen of England during the last thirty years, was returned.

The Kehl (Rhine) Bridge.—On the 6th September ult., some French engineers, and 100 workmen, commenced the construction of a temporary bridge over the Rhine, which is to be completed within two months, and will serve for the transport of the materials for the construction of the "permanent International Railway" Bridge.

A Military Bridge, connected with the new works in progress for the defence of Vienna, is to be thrown over the Danube; it will be defended by two *têtes-de-pont*.

Trent Valley Railway Bridge.—The total destruction of the bridge on the Trent Valley line, near Stafford, and by which a stoppage of traffic from that place to Rugby is occasioned, took place on the 22nd September ult. At a short distance from Baswick, and about a mile and a quarter from Stafford, the line crosses the river Penk and the Canal, which at that point run nearly parallel with each other. Across them a wooden viaduct, 150 yards in length, had been erected. The fire was first discovered between one and two in the morning. The flames ran along the wood with fearful rapidity. By six o'clock the once massive structure had disappeared, and nothing remained to indicate its former position but the lines of rails, which were suspended, says the "Manchester Guardian," in mid-air, "like tight-ropes," from one end of the gaping chasm to the other.

The New Westminster Bridge, although progressing, will not, it appears, be opened, as announced, in October or November of the present year. The contracts for the ironwork have been so recently entered into by the Board of Works, that some time must elapse before the material for the rib arches will be ready. All the first halves of the stone piers have, for some time past, been finished, and now four of the other halves are being erected under the old bridge, and are just rising to low-water level. The dimensions, &c., of the new bridge are, or rather will be, as follows:—Total length from extreme abutment to abutment, 1,160 ft.; width, 85 ft., giving 15 ft. for each path; breadth of roadway, 50 ft.; greatest height of centre arch, 22 ft. above high-water mark; depth of foundation, 30 ft. below low-water mark, or more than 20 ft. into the London clay; rise on the whole bridge, 5 ft. $3\frac{1}{2}$ in., apparently half the rise of the old bridge, though in reality much less, since it joins the roadway at a much lower level; number of arches 7, instead of 13, as in the old, so that the water-way will give a greater area by 2,600 ft.; span of centre arch, 120 ft.; of two next, on each side, 115 ft.; of two next, 104 ft.; of two shore arches, at Surrey and Middlesex, 94 ft. each. Total cost, £235,000, or £2 8s. 6d. per superficial foot. Pressure on foundations, $2\frac{1}{2}$ tons. Shape of the arches (something quite new in the history of bridge-building), a curve, parallel with an ellipse, imparting to the whole a graceful sweeping outline. Bearing piles (of foundations), elm, 14 in. square, driven home at intervals of 1 ft. 9 in. from centre to centre to an average depth of 20 ft. Round these bearing-piles is a casing of cast-iron piles and plates, the whole mass bolted together in all directions by a crossing series of wrought-iron tie-rods. This peculiar iron casing, answering all the purposes of a permanent coffer-dam, is composed of forty-four cast-iron circular guide-piles, 25 ft. in length, each 15 in. in diameter and 1 in. thick, driven in at intervals of 5 ft. 6 in., intervals afterwards filled in with sheeting-piles, so that the whole foundation is bound in and faced with a casing of wrought and cast iron. The space thus enclosed is then dredged down between the bearing-piles to the bare gravel bed, and filled in with concrete, so as to form a solid mass. The cast-iron sheeting-piles, between the circular guide-piles, cease at 6 ft. below low-water line, and the piers are there faced with enormous slabs of granite 20 in. thick. All the exterior of the piers above low-water mark is granite, and so continued up to the height, whence the arches will spring 2 ft. above high-water mark. The piers are to be surmounted with octagonal pillars, which are now in course of preparation, and consisting of immense blocks of gray granite (weighing from 15 to 20 tons each), with moulded capitals and bases, all to be cut from the solid block. They are from the Cheesewing and Penrhyn Quarries, in Cornwall.

AGRICULTURAL MACHINERY, &c.

Steam Ploughing.—The steam plough is started in Cuba, the sugar growers already are demanding it in Jamaica and Demarara, where the blacks won't work (?), and indeed the West Indies first agitated the question, experiments having been made ten or twenty years ago with especial view to their requirements. Our continental friends, too, make large purchases in England of engines, reapers, and labour-saving tools, being fully awake to the merits of steam power in husbandry.

A New Steam Thrashing Machine has been exhibited in New York. Its construction is described as being entirely new, and with a 4 H.P. it will thrash, clean from smut, winnow, measure, and bag, from 1,000 to 2,000 bushels of any kind of grain or seed (except maize or Indian corn) per day. As a mechanical aid in farming operations, it ranks in interest with M'Cormick's reaper, and is said to be attracting great attention.

Steam Thrashing Machines, it appears, have so multiplied that in the last few years one maker has sent out 2,000, and there is a still increasing demand for the perfected reaping machine. Farm machinery for various other purposes is eagerly sought for. The "Rotary Delver" is fast superseding manual sowing implements, and light "Traction Engines" are being constructed for tolerably level districts, to draw the threshing mill from farm to farm, to cart manure to the field and produce to the farmstead, or convey the grain and hay and wool to market. The universal adoption of steam ploughing and scarifying would, it is calculated, alone dispense with one-third of the million farm-horses working the 20,000,000 acres of arable in Great Britain, leaving their food to be converted into good beef and mutton, instead of into horse-flesh, now wasted in hard labour. The £10,000,000 worth of corn and fodder saved from annual consumption in tilling the land (on the old method) would find its way to market in the shape of some 400,000 fat bullocks, equivalent to a hundred times our weekly metropolitan supply. The superiority of steam culture over the old plan is practically and abundantly proved by its successful employment by many of the great landed gentry, not only in Scotland (by the Marquis of Tweeddale, for instance), but also in Lincolnshire, Staffordshire, Worcestershire, Wiltshire, Essex, Herts, and elsewhere.

MINES, METALLURGY, &c.

Oural Gold-fields.—From an official return published at St. Petersburgh it appears, that the quantity of gold-dust crushed in the Oural Mountains last year was 431,504,551 *pouds*, and the quantity of gold obtained 1,182 *pouds* (129 pouds more than in 1856). The *poud* is rather more than 33 lbs.

Fatal Accident in "Blasting."—A melancholy occurrence, resulting in the instantaneous death of one man, and the serious injury of another, took place on the 28th August ult., at Chalderness, Parish of Tingwall, in Shetland. A quarryman was engaged in blowing up, by means of a charge of powder, some stones at a place where a new croft is in course of formation. The train of one of the "blasts" having only burnt halfway, another attempt to get it to go off was equally unsuccessful, when it was resolved to blow it again. The hole had been bored pretty nearly to the powder, when a spark produced by the iron employed in boring, reached it. The consequent explosion drove the iron right into the forehead of the unfortunate quarryman, killing him on the spot. Another man close by was struck by the stones blown up, and much injured.

Puddling Iron by means of Wood Gas is, it appears, already practised on a large scale at the Villotte Iron Works, near Châtillon, in France. It has for some time past been adopted with success in the forest districts of Germany, especially in the smelting works of the Archduke John, himself a practical worker in iron. The apparatus used at *la Villotte* consists of drying-chambers for the preliminary desiccation of the wood (a point, it seems, of indispensable necessity), heated by the gas of the puddling-furnace, and of a "generator," or gas-retort. The operation takes, on an average, 1 hour 35 minutes; and the iron produced is described as compact in grain and remarkably tough, working well.

Russian Iron Mines.—Two horizontal steam-engines, of 150 H.P., with expansion-valves, upon the equilibrium principle, are now finishing by Messrs. Handyside and Co., of Derby, for Siberia, by order of the Russian Government. The engines are coupled together, and to work at quarter-strokes. The fly-wheels are over 5 tons; three pumps, 20 in. diameter each, two of them lifting and one plunging; four boilers, with double fire-boxes and flues, constructed for burning wood, each 30 ft. long, and 6 ft. 5 in. diameter. Destination, Irkutch, on the river Lena, in lat. 63° north, long. 135° east, or about 5,000 miles from Derby. To be employed in pumping water from an iron mine 600 ft. deep, belonging to the Russian Government.

The Coumi Coal Mines in Greece.—From the official report, recently published, of the Greek Government on the mines of Coumi, it appears that these mines are distant 2,659 metres from Coumi, and from the nearest seaport 6,326 metres. They are situated in a small valley, surrounded on all sides by hills. Up to the present time, three galleries have been opened in this valley. The northernmost, by which the first works were executed, is faced throughout with solid masonry; it is now abandoned, having been choked up by fallen materials and *debris*, as is also the southern one, because, at a depth of about 40 metres, towards the centre of the mountain, the yield was found to be insufficient. The centre gallery, now being worked, is 60 metres deep. Lieut. Boujoukas reports favourably of the prospects of these mines, he having, in one of the galleries, found a seam 6 metres in thickness, with every appearance of its extending to a great distance towards the sea-coast.

Consumption of Iron for Ribs, Girders, &c.—The iron contracts given to Messrs. Cochrane and Co., of Woodside, for the New Westminster Bridge, afford a striking example of the increasing use of iron for modern building purposes. The total amount required for the whole superstructure is 2,557 tons of cast-iron, 1,257 tons of wrought-iron, or 3,814 tons in all. In addition, there will be 289 tons of ornamental castings for the parapet, outside ribs, and cornice.

A Spanish Coal-pit.—The Queen of Spain and Royal Family, says the "Espana," recently visited the coal-mines in the neighbourhood of San Juan. Her Majesty, in spite of persuasion to the contrary from the President of the Council, &c., insisted on descending into the principal pit, which is upwards of 350 ft. deep, and on going further in the pit than any one had ever been. Accordingly, accompanied by the King, attended by the Director, and by the Engineer, Mr. Smith, she descended—the Minister and General Lemery having previously gone down in order to receive her. The Queen then went along the principal gallery of the pit, which goes on an incline upwards of 300 yards—great part of this under the sea. Arrived at the very extremity, the Queen formed her initials on a large block of coal, by means of drops from a tallow candle. The Director declared that no female had ever had the courage to go so far; and he requested and obtained permission to place a stone on the spot to perpetuate the remembrance of the visit. When the Queen ascended to the orifice, the assembled miners cheered enthusiastically.

Quartz Crushing (for Gold) in Australia.—Late advices from Melbourne give us some idea of the operations of the auriferous quartz-crushing companies. Of one of them (Clunes) we learn—"During the month of June, 1,405 tons of quartz were crushed against 1,098 the previous month. The yield of gold was 2,136 oz.; the cost of crushing averaged £1 8s. 9d. per ton for the month. The result of the six months' working showed 7,055 tons quartz crushed—amount received for crushing same was £18,240; the expenditure, £11,371; profit, £6,869. The machinery crushed on an average 350 tons per week. The quantity of gold melted during the month of June amounted to 38,376 ounces; and during the six months, 234,970 ounces; and showed a profit of £637. The Clunes Mining Company have divided during the twelve months £17,600 in the shape of dividend, or £160 per share.

Fall of a Roof.—At one of the iron mines at Alston, near Durham, a fatal accident occurred to three men, whilst engaged in working the Manor House vein: the roof of the mine gave way, and about 15 tons of stone fell upon them. The stone had to be blasted before the men could be got out. Two of them were dead, and the third died within eight hours.

A Vein of Coal on Fire.—In the Evail Fach coalpit, at Tindu, in Glamorganshire, a volume of smoke was perceived proceeding from the air-shaft. It was discovered that a vein of coal had caught fire—it is conjectured, from a spark emitted from the engine used underground. In less than an hour the whole of the men were brought up, no one, fortunately, having sustained injury. The water-course was then turned into the pit.

The "Welcome" Monster Nugget.—In our last month's "Notes and Novelties" we mentioned the discovery, at the Ballarat Diggings, of this huge nugget, the largest piece of virgin gold ever yet met with. Some interesting particulars respecting it have since been received. It was found at 8 o'clock in the evening of the 8th June last, at Bakery Hill, Ballarat, about 190 ft. below the surface, and it is a splendid specimen of almost *pure gold*. The dimensions are:—Greatest length, 17 in.; breadth, 11 in.; thickness, 7 in.; weight, 184 lbs. 9 oz. 16 dwts. Troy. Estimated value, £10,000; by other accounts, its intrinsic value is calculated at £8,700. The lucky finders consist of a party of 22 Cornish miners, all (excepting one) Welshmen. The "Ballarat Times," remarking on the singular form of this nugget, says:—"It had a narrow escape from being two nuggets instead of one, for at a point one-third from the end its continuity is only maintained by a narrow neck, which is so slight that the men were afraid to handle their prize much, lest they might break it in two. It looks like a continent with a peninsula attached to it by a narrow isthmus; and it bears upon its sides the marks of several hard blows from the pick." The "Ballarat Star" states that this "last wonder of the world" has been publicly exhibited in the Miners' Exchange, for the benefit of the Hospital, at an entrance-fee of one shilling; it reposes on a wooden hand-barrow or tray, the precious yellow mass being relieved by a black velvet cloth underneath.

The Frazer River Gold Diggings (British Columbia).—Late advices tend to confirm the fact that there is no scarcity of gold on Frazer River. At Texas Bar 100 miners were at work, earning from 10 to 20 dollars each daily. At Puget Sound Bar, 75 men, earning from 8 to 10 dollars a day. At Hills Bar, 700 men at work, earning from 10 to 50 dollars a day. At Fort Yale, 200 miners, earning from 10 to 20 dollars a day. At Kett's Bar a fine log-house had been erected. Workings all along the river reported good; the banks at present worked with sluices and "rockers." A small screw-propeller had been shipped at San Francisco to Frazer River.

Assay of Ore.—The following is the result of the assay (at New York) of the Frazer River gold. First deposit—gold, fineness, 816 thousandths; silver, 1·54 thousandths: second deposit—gold, $847\frac{1}{2}$ thousandths; silver, 154 thousandths. The assays prove the Frazer gold ore to be nearer the character of the Californian ore than that of the Australian, which latter has no silver, yielding pure gold. The steamer *Golden Age* arrived at Panama, on the 3rd August ult., with gold to the value of 1,826,000 dollars.

A FATAL EXPLOSION OF FIRE-DAMP occurred on the 16th September ult. at the New Tredegar Coal-pit. One of the sufferers, a hauler, died before he could be removed from the pit. Another was burnt to a cinder. His lamp, which was open, was found about 10 yards in front of him, and he must have been blown from the spot where the lamp was found. A "blower," or jet of inflammable gas, had, it is supposed, opened during the night, and the fireman, quitting his post with a naked light, caused, in all probability, the gas to explode.

ANOTHER FATAL EXPLOSION, from the same cause, namely, fire-damp, recently occurred at the Aberdare Colliery.

APPLIED CHEMISTRY, &c.

ADULTERATION OF WAX.—Professor Fehling has made known a process for detecting some of the numerous frauds which, it seems, are commonly practised in the preparation of wax as an article of commerce. The substances added are mostly fecula, gypsum, kaolin, and even water, with which the wax is made to incorporate. The presence of matters not capable of fusion may be easily detected, as they may be separated by solution of the specimen in essence of turpentine, benzine, &c. The water, which may have been combined with the molten wax by shaking or stirring whilst cooling, separates and evaporates when the wax it is re-melted; but it is by far a more difficult matter to detect.

ELECTRICITY AND DENTISTRY.—A new and, as it would appear, successful application of the electro-magnetic coil machine, to diminish danger and suffering in the operation of extracting teeth, has been made by Mr. J. B. Francis, of Philadelphia—producing local anæsthesia by the application of the electric current. The handle of the forceps is connected, by means of a brass binding-screw, to the negative pole of the machine, and when the instrument is adjusted on the tooth, the patient takes hold of the handle attached to the other pole, so that the circuit is completed only at the moment of extracting the tooth.

URIC ACID.—A gold medal is likewise offered for the discovery of a means of preparing uric acid, now so advantageously used in dyeing and in printing of goods, otherwise than from animal secretions.

THE BORATE OF PROTOXIDE OF MANGANESE has lately been successfully adopted in France in the preparation of dried linseed oil for varnish, &c., as a substitute for the salts of lead hitherto employed. A very fine and easily drying varnish is thus prepared:—20 grammes of borate of protoxide of manganese, very white, and precipitated cold, is ground up with a little oil, 4 *litres* of linseed oil, as old as possible, are then added, and the mixture placed in a copper or tin boiler, and kept boiling in a vapour bath, with occasional stirring, for two or three days. When cold, the oil should be well stirred again before mixing up with colour, in order to distribute equally throughout the mass the borate, which has a tendency to sink to the bottom. The brownish-yellow tint of the linseed oil has passed to a greenish-yellow, but not to a deep brown, as is the case when the borate has been precipitated with heat.

THE "INDUSTRIAL SOCIETY" OF MULHOUSE has just published its annual notice of prizes to be awarded in 1859 for inventions, improvements, &c., applicable to manufactures. Amongst these we find the offer of a gold medal for a substance (not being any of the gums hitherto in use) that will serve for thickening colours and dressings for dyeing, and which shall be an efficient substitute for the starch, fecula, &c., now usually employed, so as to avoid the necessity of withdrawing from general consumption substances which form a staple of human food.

THE NEW (CARBON) PHOTOGRAPHIC PROCESS.—MM. Garnier and Salmon have invented a new photographic process, depending upon the adhesion of lampblack to citrate of iron, which has not been exposed to the light. This process, it is alleged, does not differ in principle from those recently announced by Mr. Pouncy and M. Testard de Beauregard, excepting in the substitution of citrate of iron for bichromate of iron, and in the mode of working.

THE "Journal des Débats" claims for a French dentist, M. Simon, the invention of the electro-magnetic apparatus for the painless extraction of teeth.

HARDENING COPPER-PLATES.—An invention has been patented for preparing the surface of an engraved copper-plate, so as to render it capable of yielding an increased number of impressions. It is stated that upwards of 10,000 impressions have been taken from a plate thus prepared.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 22nd April, 1858.

890. P. E. Aimont, Paris—Railway indicating and signalling apparatuses.

Dated 10th May, 1858.

1040. C. F. Vasserot, 45, Essex-street, Strand — Driving machinery, applicable either for thrashing, winnowing, cleaning, or other agricultural purposes.

Dated 19th July, 1858.

1620. C. F. Vasserot, 45, Essex-street, Strand — Artificial manure.

Dated 20th July, 1858.

1636. R. Clarke, Cwmbran, near Newport, Monmouthshire —Windows, window-blinds, and shutters.
1642. W. Asquith and J. Asquith, Leeds—Ornamenting the surfaces of raised pile fabrics, and in the apparatus employed therein.

Dated 24th July, 1858.

1668. W. Merry, 9, Park-place-villas, Paddington—Apparatus for preventing the escape of foul air from area, kitchen, and scullery drains of dwelling-houses.

Dated 27th July, 1858.

1693. A. Taylor, 1, Wellington-cottages, De Beauvoir-town, Kingsland—Pianofortes.

Dated 4th August, 1858.

1773. C. M. Archer, 3, St. James'-gardens, Haverstock-hill, Hampstead road—Submarine telegraph cables and wires.
1774. J. B. Pascoe and J. R. Thomas, Chacewater, Cornwall —Method of, and apparatus for, feeding boilers of all steam engines with liquid, without the aid of the force pump heretofore used.

Dated 5th August, 1858.

1776. J. Luis, 1B, Welbeck-street, Cavendish-square—System of truss.
1780. W. Moseley, 17 and 18, New-street, Covent-garden, and W. S. Champness, Clapham—Self-filling reservoir penholders.
1782. J. Henderson, Lasswade, Mid-Lothian, N.B.—Machinery for weaving plain or figured fabrics.
1784. C. Mather, Salford Iron Works, Manchester—Shearing machines.
1786. W. Clay, Liverpool — Manufacturing cast steel and wrought iron into ingots and other forms.
1788. A. V. Newton, 66, Chancery-lane—Manufacture of lace.

Dated 6th August, 1858.

1790. C. Barthémely, 27, Rush-la., London—Certain improvements in hats.
1792. F. H. Stubbs, Leeds—Communicating between the guard and engineman on locomotives or railway trains.
1794. S. Carey, Clink-street Wharf, Bankside, Southwark—System of forming the permanent way of railroad transit, also common tramway, by the means of cast-iron plates, or boxes peculiarly constructed, so as to make one continuous way or channel.

Dated 7th August, 1858.

1796. G. P. Lock, Liverpool— Composition of paints for coating iron ships and other purposes.
1798. J. Webster, Birmingham—Metallic alloy.
1802. J. Imray, 65, Bridge-road, Lambeth—Apparatus used in printing.
1804. J. Walker, Glasgow — Apparatus for moulding or shaping metals.
1806. A. V. Newton, 66, Chancery-lane—Pianofortes.

Dated 9th August, 1858.

1808. J. J. Murphy, Belfast—Construction of floating bodies, and in the means of supporting floating structures.
1810. H. Clayton, Atlas Works, Upper Park-place, Dorset-square—Machinery for manufacturing bricks and tiles.
1812. T. G. Messenger, High-street, Loughborough—Manufacture of garden engines, which are also applicable to fire or other engines.
1814. W. E. Newton, 66, Chancery-lane—Method of arranging and applying magnets to counteract or compensate for the effects of local attraction on the mariner's compass.
1816. W. Spence, 50, Chancery-lane—The precipitation of purple colouring matter by chloride of calcium.

Dated 10th August, 1858.

1818. A. Barchou, 49, St. Augustin's-road, Camden-town—Fastening the soles and heels of boots and shoes.
1820. R. H. Collyer, M.D., 3, Park-rd., Regent's-park—An improved coating composition to protect vessels from marine, animal and vegetable substances.
1822. M. Moses, Portsdown-road, Maida-hill—Umbrella and parasol sticks.
1826. R. C. Gist, 36, Cannon-street—Knitting machines.
1828. J. G. Appold, Wilson-street, Finsbury-square—Manufacture of wire ropes or cables.
1830. E. Tamberlick, Rue du Commerce, Quartier Leopold, Brussels—Apparatus used for exhibiting advertisements.

Dated 11th August, 1858.

1824. J. T. Pitman, 67, Gracechurch-st.—An improved mode of operating apparatus for lifting and pressing.
1825. S. F. Cottam, Manchester—Machinery for doubling cotton and other yarns or threads.
1827. J. B. Foyce, St. Dunstan's Works, Conway-st., and J. Cure, J. Boyes, and J. Clough, Ebenezer Mill, Mill-lane, Bradford—Apparatus for combing wool and other fibrous materials.
1829. R. A. Brooman, 166, Fleet-st.—Time-keepers.

Dated 12th August, 1858.

1831. W. Meckel, Friday-st.—Textile fabrics.
1832. W. Knowles, Bolton-le-Moors, Lancashire—Machinery used in preparing and spinning cotton and other fibrous materials.
1833. J. Scott, Shoreham, and A. Martinucci, Brighton—Steam engine.
1834. G. Houghton, Birmingham—Saddles.
1835. J. H. M. Maissiat, Paris—Wheels.
1836. G. Metzler, Great Marlborough-street, and J. Waddell, Brompton — Formation of valve musical instruments.
1837. J. Fogg, Great Lever, near Bolton, Lancashire—Pressure gauges.
1838. R. Baxendale, Manchester—Brushes, mops, or apparatus for washing and cleaning.
1839. A. J. Paterson, Edinburgh — Propelling ships and vessels.
1840. R. Jobson, Wordsley, Staffordshire—Apparatus used when making moulds for casting shells and other articles.
1841. E. Smith, Dudley Port, Tipton, Staffordshire—Puddling iron.
1842. R. Jobson, Wordsley, Staffordshire — Apparatus for supplying water to axletree boxes and other journal bearings to lubricate the same.
1843. H. Smith and T. W. Ashby, Stamford—Imp. applicable to haymaking machines, whereby such machines are rendered useful for other agricultural purposes.
1844. R. Jobson, Wordsley, Staffordshire—Apparatus for crushing and sifting.

Dated 13th August, 1858.

1845. W. B. Nortcliffe, Fellgrove, near Huddersfield—Dyeing woollen, worsted, and other textile fabrics and fibrous substances.
1846. L. Autra, Wardour-st.—Exhibiting advertisements.
1847. F. J. Manceaux, Paris—Stocks for firearms.
1848. C. L. Light, Pall-mall East—Electric telegraph ropes or cables.
1849. T. Rickett, Castle Foundry, Buckingham—Locomotive engines and other carriages to facilitate their transit.
1850. J. Petrie, jun., Rochdale—Apparatus for stretching and drying woven fabrics.
1851. T. Worth and H. Spencer, Rochdale—Apparatus for preparing for spinning, and for spinning cotton and other fibrous materials, in winding and warping yarns of the said materials, and making wire cards for such preparing machinery.
1852. G. Schaub, Birmingham—Machinery to be used in the manufacture of certain kinds of printing types.
1853. J. H. Johnson, 47, Lincoln's-inn-fields—Treatment of crude india-rubber, gutta percha, or other vulcanizable gums, and in the manufacture therefrom of what are usually called hard rubber articles.
1854. T. G. Pengelly, 5, Cheshunt-terrace, Waltham-cross, Hertfordshire, and H. Brown, Old-road, Enfield-highway—Apparatus for straightening gun-barrels.

Dated 14th August, 1858.

1855. J. Cartmel, Stamford-st.—Manufacture of hats, caps, and other coverings for the head.
1857. J. Holt, Shelf, near Halifax—Looms.
1858. J. Smith, Seaforth, near Liverpool, and S. A. Chease, Liverpool—Obtaining and applying motive power.
1859. A. Slate, Adelaide-road, Haverstock-hill—Blast furnaces and smelting iron ore.
1860. S. C. Lister and J. Warburton, Manningham, Yorkshire —Dyeing wool, hair, cotton, flax, and similar materials; also yarns and textile fabrics made from such materials.
1861. C. O'Neill, Manchester — Manufacture of artificial gums from starch, farina, and other amylaceous substances, and in apparatus for such manufacture.
1862. G. Betjemann, G. W. Betjemann, and J. Betjemann, Upper Ashby-street—Book slides.
1863. W. E. Newton, 66, Chancery-lane—Combination of metal with india-rubber or gutta percha, or with india-rubber or gutta percha combined with other substances, in the manufacture of belting, hose, valves, and other articles.

Dated 16th August, 1858.

1865. G. K. Geyelin, London—Folding bedsteads.
1866. P. E. Chappuis, 69, Fleet-st.—Stereoscopes and stereoscopic apparatus.
1867. C. G. Cutchey, 15, Portland-cottages, Forest-hill—A railway danger-signal whistle.
1868. L. A. Herrmann and E. I. E. Herrmann, Paris—Connecting together pipes, tubes, or ways, for the conveyance of water or other fluid.
1869. A. V. Newton, 66, Chancery-lane —Machinery for forging horse-shoes.

Dated 17th August, 1858.

1871. J. Webster, Birmingham—Improved projectile.
1872. W. E. Evans, Norfolk-st., Sheffield —Harmoniums, concertinas, organs, and other similar keyed instruments.
1873. J. Jackson and A. Fisher, Highfield Steel Works, Sheffield—Hats.
1874. G. Halkerston, Frenchie, Fife, N.B.—Mangles.
1875. J. Norton, Rosherville, Kent—Projectiles.
1876. F. Shaw, Siddals-road, Derby—Spindles for the spinning of silk and other fibrous material.
1877. G. Mills, 5, St. George's-terrace, Queen's-rd., Regent's-park—Machinery for cutting wood for staves.
1878. D. Lichtenstadt, Surrey-square, Old Kent-road, and C. Duff, Hill-street, Peckham —Treating tan and tanning refuse to obtain valuable products therefrom.

Dated 18th August, 1858.

1879. J. Luis, 1B, Welbeck-street, Cavendish-square — System for preventing an accidental discharge in fire-arms.

1881. W. Soelman, 3, Bennett-street, Middlesex — Additional improvements in the construction of propellers, chiefly with reference to my former patent, Dated 20th August, 1855.
1882. T. Williams, Aberdaron, Carnarvon—An apparatus to be used for a churn or for a washing machine.
1883. R. Anderson, Black Braes, Stirling, N.B.—Stuffing boxes and packings.
1884. T. O. Duke, Kennington—Preparing cheques and such like documents, and in the means of preventing forgery or surreptitious alterations.

Dated 19th August, 1858.

1885. A. Pilbeam, 2, Lonsdale-place, Notting-hill—A bradawl screw.
1886. W. Hudson, Burnley, Lancashire, and C. Catlow, of Clithero, in the same county—Looms for weaving.
1887. W. F. Padwick, Hayling Island, Hants—Implement to be employed on land sown with turnips, to protect them from the ravages of the fly.
1888. J. C. Plomley, Maidstone—Joists and laths used for supporting hair and other pervious floors in oast-houses.
1889. M. F. J. Delfosse, Regent-street—Electro-magnetic machines.
1890. W. Smith, 18, Salisbury-st., Strand—Steam engines.

Dated 20th August, 1858.

1891. W. Pearce, Bristol—Manufacture of air-tight bottles, jars, or similar articles.
1892. W. A. Munn, Thorley House, near Feversham—Method of constructing railway carriages.
1893. F. Preston and W. McGregor, Manchester—Machinery for cutting files.
1894. H. Hood, Leeds Iron Works, Leeds—Manufacture of railway tyre-bars, boiler plates, bar iron, and forgings.
1895. L. F. H. Droinet, Paris—Bearings and packings for rotating and reciprocating shafts, and joints of pipes.
1896. P. Spence, Pendleton, Lancashire—Manufacture of alum.
1897. J. L. Figgett, Missionary-place, Walworth—Construction of syringe or hand pump.
1898. W. Clay, Liverpool, and E. L. Benzon, Sheffield—Manufacture of iron and steel.
1899. T. Knowles, Gomersal, Yorkshire — Looms for weaving.
1900. A. Baker, 6, Lambeth-rd., Southwark—An improved method of and apparatus for submerging or laying under water electric cables, wires, or lines, and for the recovery thereof.

Dated 21st August, 1858.

1901. F. F. Delpy, Paris—Metallic stay busks.
1902. G. J. Walker, Norton Folgate—Funeral carriages.
1904. R. A. Brooman, 166, Fleet-street—Sewing machines.
1905. W. Henson, St. Just, France—Circular looms, or knitting frames.
1906. C. De Jongh, Lautenbach, near Guebwiller, France—Machinery for combing and heckling fibrous materials.
1907. R. Laming, Hayward's-heath, Sussex—Purifying gases and liquids in preparing purifying liquids.
1908. W. W. Harrison, Sheffield—Cruet and liqueur stands.

Dated 23rd August, 1858.

1909. F. Puls, Roxburgh-terrace, Haverstock-hill—Distillation of coal.
1910. F. Puls, Roxburg-terrace, Haverstock-hill—Distillation of bituminous matters and gas tar.
1911. M. R. Pilon, United States—Construction of firearms, and in means of loading the same.
1913. L. Higgins, Jersey City, and A. Brown, New York, America—Reefing the sails of navigable vessels.
1914. A. Boyle, Birmingham—Manufacture of certain parts of umbrellas and parasols, and machinery employed in the said manufacture.
1915. T. Averill, Birmingham—Mills for grinding.
1916. H. D. Jencken, London—Electric telegraphs.
1917. J. H. Robinson, Clement's-court—Shirt.
1918. W. H. Harfield, Fenchurch-street—Windlasses.
1919. A. Rottmann, Lawrence-lane—Fastenings for bags, portemonnaies, pocket books, and similar articles.

Dated 24th August, 1858.

1920. C. A. Schrader, Finsbury-square—An instrument to be used in boring for mining or other purposes.
1921. H. B. Barlow, Manchester—Self-acting lubricators.
1922. J. Hine and A. Abrahams, St. John-street-road—Book slides or holders.
1923. H. Wilson, Watling-st.—Mounting of hand saws.
1924. J. Macintosh, North Bank, Regent's-park—Insulating telegraphic wires or conductors, and apparatus employed therein.
1925. J. Biggs, Leicester—Manufacture of caps, resembling in form the Turkish fez.

Dated 25th August, 1858.

1926. H. B. Barlow, Manchester—Machinery for preparing flax, wool, and other fibrous materials.
1927. T. Hill, Heywood, Lancashire—Apparatus for punching and shearing metals.
1929. R. A. Brooman, 166, Fleet-street—Treatment of vegetable substances in order to convert the fibrous portions thereof into pulp.

Dated 26th August, 1858.

1931. J. H. Johnson, 47, Lincoln's-inn-fields—Bellows.
1933. J. Black, Edinburgh—Means of obtaining, applying, and transmitting motive power.
1935. S. N. Rodier, 21, Oak-village, St. Pancras—Apparatus for regulating gas.

Dated 27th August, 1858.

1937. D. Graham-Hope, Manchester—Locomotive and other steam engines.
1938. T. Trotman, 253, Albany-road, Camberwell — Hair pins.
1939. J. Ellisdon, Liverpool—Reading chairs, and articles used to sit or recline upon.
1940. F. Matley, Paris—Apparatus for regulating the flow of gas, and for improving its illuminating power.
1941. W. S. Clark, Banbury—Reefing or furling sails from the deck of vessels.
1942. W. Esson, Cheltenham—Wet gas meters.
1943. H. W. Hart, 69, Fleet-street—Application of gas to chandeliers.
1944. F. J. Evans, Chartered Gas Works, Horseferry-road, Westminster—Gas purifying.
1945. A. V. Newton, 66, Chancery-lane — Machinery for sorting silk or other thread according to its size or thickness.
1946. W. E. Newton, 66, Chancery-lane — Improvements applicable to vessels employed in the manufacture of glass, or the melting of vitreous substances.
1947. W. Kempe, Holbeck mills, Leeds—Apparatus used for winding woollen and other fabrics on rollers, in order to such fabrics being boiled or faced when on the rollers.
1948. John Fowler, jun., Cornhill, and R. Burton, Kingsland-road—Arrangement of locomotive and other carriages, to facilitate their movement on common roads and other surfaces.
1949. R. Knight, Foster-lane, London—Apparatus for aerating liquids.

Dated 28th August, 1858.

1950. J. Ireland, Manchester—Cupola furnaces.
1951. G. White, 34, Dowgate-hill, Cannon-street—Ambulatory furniture for apartments.
1952. W. Foster, Black Dike Mills, near Bradford—Manufacture or production of fabrics known as fancy moreens.
1953. G. Coode, Westminster—Adjustment of hose in machines for distributing liquid manure and other liquids over land.
1954. J. D. Brabazon, Lane's hotel, St. Alban's-pl., Haymarket—Giving motion by sails to screw and other propellers of ships and vessels.
1955. G. Weedon, 4, Poland-street, and D. W. Rice, 11, New-road, Woolwich — Knife and fork cleaning machine.

Dated 30th August, 1858.

1957. J. Platt and E. Hartley, Oldham—Machinery for preparing and spinning cotton and other fibrous materials.
1958. E. Massey, Tysoe-st., Clerkenwell—Ships' logs.
1959. J. Brazil and J. McKinnell, Manchester—Indigo blue dyeing.
1960. G. Davies, 1, Serle-st., Lincoln's-inn—Billiard tables and cues.
1961. J. Brazil and J. McKinnell, Manchester—Indigo blue dyeing.
1963. J. Oxley, Camden-town—Baths.
1964. G. Jones, Bangor-wharf, Pimlico—Securing joints in slate ridge roll.
1965. J. L. Clark, Adelaide-road, Middlesex, F. Braithwaite, Bridge-street, Westminster, and G. E. Preece, Bernard-street, Middlesex—Telegraph cables.
1966. E. Lindner, New York—Breech-loading fire-arms and ordnance, and in cartridges.
1967. L. Wiart, Cambrai, France—Generating steam or heating water or liquids.
1968. T. R. Harding, Leeds—Straight or circular combs for flax, wool, or silk machinery.
1969. J. H. Johnson, 47, Lincoln's-inn-fields—Construction of governors or regulators for steam engines.

Dated 31st August, 1858.

1970. E. Spary, Queen's Graperies, Park-st., Brighton—Fumigators.
1972. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Apparatus for the elevation of liquids.
1973. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Apparatus for mounting the driving bands of machinery in movement.
1974. F. Ayckbourn, Lyon's-inn, Strand—Construction of beds and other articles for sitting or reclining upon.
1975. J. Stoneham, Audenshaw, near Manchester—Cleaning and treating cotton and woollen waste or other fibrous materials, and in extracting oil or grease therefrom.
1976. D. Heyworth, Featherstall Mill, Littleborough, Lancashire, and J. Heyworth, Prospect Mill, Hebdenbridge, Yorkshire—Looms for weaving.
1978. A. V. Newton, 66, Chancery-la.—Gas burners.
1979. W. Rose, Hales Owen, Worcestershire — Piling or combining metals to be used in the manufacture of arms and cutlery, and for other similar purposes.
1980. A. V. Newton, 66, Chancery-la.—Air engines.
1981. Capt. P. D. Margesson, Woolwich — Treating sugar canes, and other canes containing saccharine matter, in the preparation of food for animals, manufacturing sugar, and worts or wash for brewing, distilling, and vinegar making, and in applying the resulting fibre in the manufacture of paper.

Dated 1st September, 1858.

1982. W. Pursall, 22, Whittall-st., Birmingham—Percussion caps.
1983. W. Phelps, Red Lion-sq.—Wet gas meters.
1984. W. Hobbs, 196, Piccadilly—Ordnance and warlike projectiles to be used therewith.
1985. J. Sloper, 215, Oxford-st.—Improved means of and apparatus for indelibly crossing or marking bankers' cheques, &c., with a view of preventing erasures or fraudulent dealings therewith.
1986. H. C. Jennings, 8, Gt. Tower-st. — Manufacture of artificial parchment, and converting the same into leather.
1987. W. Warne, Tottenham—Construction of elastic pavements and linings for walls, and manufacture of elastic mats, brushes, and pads for packing furniture.
1989. W. E. Newton, 66, Chancery-la. — Construction of locks for doors, safes, and other purposes.
1990. W. E. Newton, 66, Chancery-la.—Springs for carriages and other purposes.
1991. S. Laing, Millwall—Apparatus employed in the manufacture of gas.

Dated 2nd September, 1858.

1992. J. Walker and J. Barnes, Oakenshaw, Lancashire—Blankets and lappings for machine and block printing and other similar purposes.
1993. G. Price and W. Dawes, Wolverhampton—Steam engines, steam boilers, and apparatus connected therewith.
1995. J. T. Pitman, 67, Gracechurch-st. — Construction of pneumatic condensing apparatus, for the purpose of compressing air or gaseous bodies preparatory to their use as prime motors, or for other purposes.
1996. B. Winstone, 100, Shoe-la.—Composition of copying and writing inks.

Dated 3rd September, 1858.

1997. J. M. Bellanger, 41, Rue de Trévise, Paris—Caoutchouc socks or clogs, with springs and without bridles.
1998. J. Robertson, Glasgow—Driving belts and springs.
1999. W. Harkes, Lostock, Gralam, Cheshire — Improved plough and pulverizer.
2000. E. Cocker, Newton Heath, near Manchester—Machinery for spinning, twisting, or doubling cotton, flax, silk, wool, or other fibrous materials.
2001. G. T. Bousfield, Loughborough-park, Brixton—Knitting machinery.
2002. R. A. Brooman, 166, Fleet-st.—Apparatus for supporting the skirts of ladies' dresses.

Dated 4th September, 1858.

2003. A. Guye, Clerkenwell—Escapements of chronometers and watches.
2004. R. P. Lavie, Paris—Mills.
2005. R. A. Brooman, 166, Fleet-st. — Apparatus for receiving, containing, and delivering liquids.
2006. W. H. Child, Providence-row, Middlesex—Hair and skin brushes.
2007. W. P. Piggott, 16, Argyle-st., Regent-st., and S. Beardmore, 37, Upper Berkeley-st.—Vinous and fermented liquors.
2009. A. V. Newton, 66, Chancery-lane—Firearms.
2010. H. Hyde, Truro, Nova Scotia—Construction of carriage springs.
2011. A. Hills, Blackheath, Kent—A method for the better securing the integrity or genuineness of bankers' cheques or orders for money.

Dated 6th September, 1858.

2013. S. Hoga, 14 Nassau-st., Middlesex Hospital, W. P. Piggott, 16, Argyle-st., Regent-st., and S. Beardmore, Upper Berkeley-st.—Submarine electric telegraphs.
2015. J. Ramsbottom, Accrington, and T. Watson, Baxenden, Lancashire—Machinery or apparatus for weaving.
2017. H. J. Distin, 9, Great Newport-st., Leicester-sq.—Cornets and other musical wind instruments.

Dated 7th September, 1858.

2019. W. S. Champness, 10, Osborne-ter., Clapham-rd., Surrey—Syringes for male and female use.
2021. H. Fullwood, Queen-sq., Bristol—Manufacture of cements.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

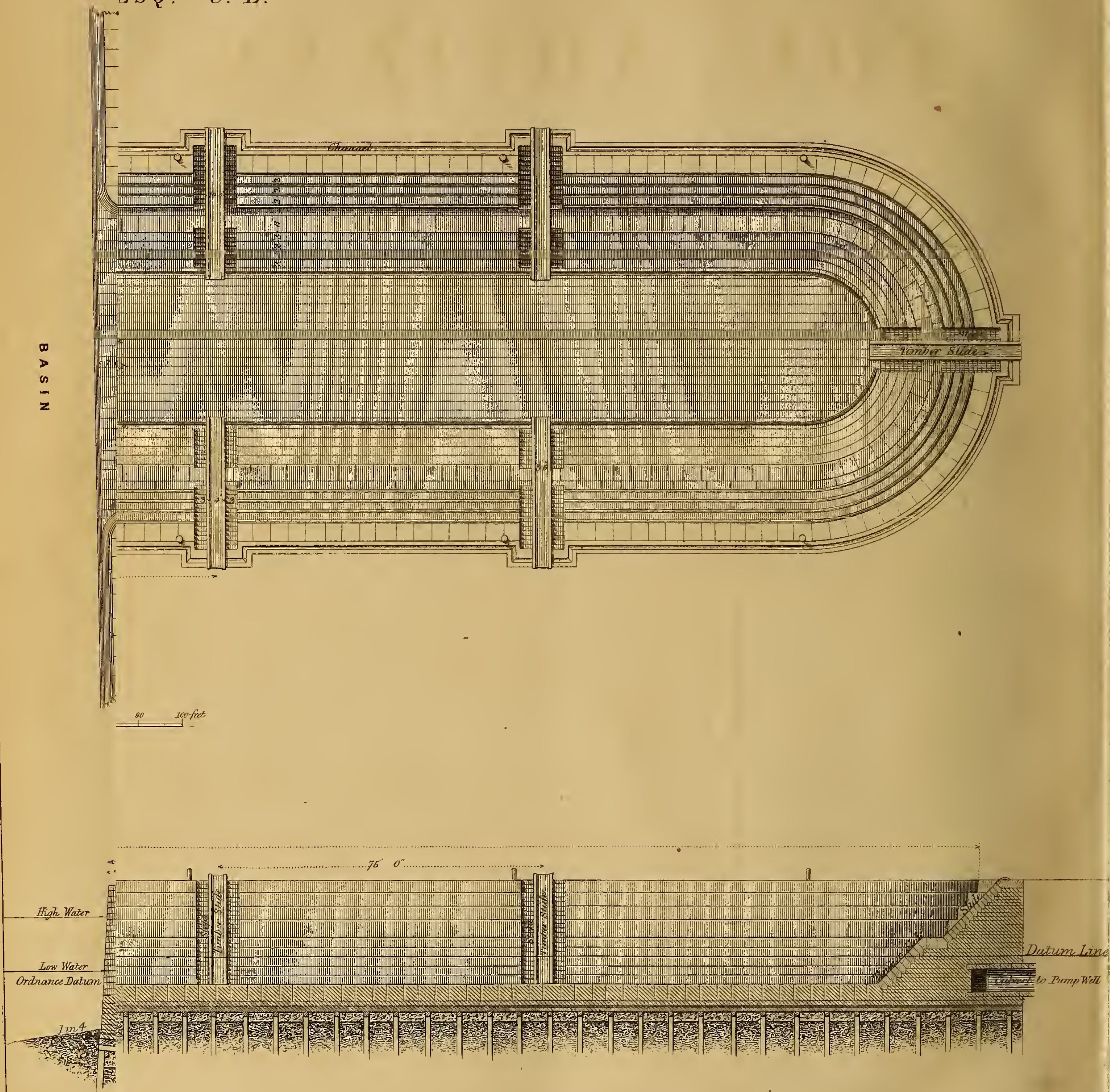
1880. A. V. Pinta, 63, King William-st. — Imp. in blank forms of cheques or drafts on bankers, payable on demand, relating to the crossing of such cheques or drafts.—18th August, 1858.
1971. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Supports of rails for railways.—31st August, 1858.
1977. J. H. Johnson, 47, Lincoln's-inn-fields—Prevention of steam boiler explosions.—31st August, 1858.
2022. G. G. Bussey, 12, Arthur-street, New Oxford-street—Holding and carrying cartridges.—7th September, 1858.
2023. W. Tucker, Rhode Island, U.S. — An improved variable boring bit.—7th September, 1858.
2083. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A new system of moulding without foundry pattern.—14th September.

DESIGNS FOR ARTICLES OF UTILITY.

4116. August 30. G. Barnes, 9, New-court, Goswell-street, "Improved Braces."
4117. „ 30. A. Browse, Grove-villa, Compton, near Plymouth, "Church Hassock."
4118. Sept. 15. T. Patstone, 8, Icknield-sq., Monument-la., Birmingham, "Improved Hall Lamp."
4119. „ 20. S. Robb and J. Waudly, Oatwell, Cambridgeshire, "Root Slicer and Cutter."

LIN HARBOUR,

ESQ^R C. E.



W. Smith, C.E. del

THE ARTIZAN.

No. CXC.—Vol. XVI.—NOVEMBER 1st, 1858.

NEW GRAVING DOCK, DUBLIN.

(Illustrated by Plate No. cxxxiii.)

We have much pleasure in presenting to our readers the plan and longitudinal section of this large work, a cross section of which we published in our April Number. The entrance to the dock is 70 ft. in clear width, and is composed of apron, invert, lock pit, and inner invert, all built in the most substantial manner, of granite laid in foot courses of alternate headers and stretchers.

The sea wall, or frontage to the dock, is built with a batter of 1 in 12, and, as will be perceived by the section, is based 3 ft. below the general level of the dock foundations. This arrangement will permit the dredging of the outer basin to a uniform depth of 12 ft. at low water spring tides, the foreshore being set at an inclination of 1 in 4.

The outer row of piling is driven closely as sheet piling, and with a batter of 1 in 12, with wales and thorough bolts: the two inner rows of main piling are also driven with a batter. The courses of masonry in the sea wall, and under the apron, have their beds laid square with the face of the wall, which is carried round to the first invert, forming the "cheese-head" entrance to the dock.

The walls of the first invert are also carried down for a depth of 19 ft. with the batter of 1 in 12, but at that level the curve (which has a radius of 114 ft. 9 in.) commences, and is brought down to 4 ft. below low water of spring tides. In this invert (which is 20 ft. wide) is the groove for the dam, or caisson, which would be required in case of anything serious occurring to the gates; this groove is 2 ft. 3 in. in width at top and 2 ft. at bottom, and 14 in. in depth. The stones of the invert on the curved portion are laid with radial joints, and form a most compact and unyielding mass of masonry.

Immediately within the first, and between it and the second inverts, is the lock pit, which is 9 ft. wider than the other portions of the entrance, the recesses for the gates accounting for the difference; it is also deeper by 18 in. than the bottom of the inverts, which range with the top of the sill, and which is, as we before observed, 4 ft. below the low water of spring tides in Dublin Harbour. The stones of the sill, and indeed of every portion of the dock, are laid in regular breadths; those in sill being particularly large, averaging 70 cwt. each.

The inner invert is similar to the outer, excepting that it is not so wide, and has no caissou groove.

The hollow quoins are of the peculiar shape suited to Mallet and Wild's patent gates, each of one stone, many of which are considerably over 6 tons in weight, laid in 2-ft. courses.

The piling of the foundations of the entrance was particularly attended to, there being three separate rows of close piles, one under the first invert, one under the point of the sill, and one under the heel-post of the gates. These were all secured by double wales and thorough screw-bolts, with nuts and washers; and between these the main piles were regularly placed at equal intervals. All through the dock foundations the cross-pieces and sleepers were secured to the piles by scrap-iron holding-down screws, cut by machinery on the ground, and screwed down by an ingenious capstan-headed tool. These screws were 5 ft. long by 1½ in. diameter, and their cutting formed one of the matters of curiosity to the various visitors to the works. Their grip in the timber is remarkable, and they were tested on several occasions with particular severity.

Considering the great depth below the lowest spring tide that this foundation was laid, too much care could not be taken to counteract the immense upward pressure of the water. The sequel has proved that the engineer's labours have been crowned with success, for there is not in the world a more thoroughly staunch graving dock than that we have been describing. Placed at the mouth of three rivers, in a deep bed of alluvial gravel as porous as a sponge, surrounded by innumerable springs, it required such experience as Mr. Halpin possesses to carry through the undertaking in the manner it has been accomplished, and to that gentleman and his assistants much credit is due.

Immediately within the second invert the steps and altars of the dock commence, as shown in our April Number; and at 5 ft. from the invert, at either side, are the openings into the filling and emptying culverts which surround the dock, meeting at the head in the large culvert which leads to the engine-well now in progress of construction by the Messrs. Toomy, of Dublin.

These culverts will be provided with sluices to work in grooves, and by those, and the sluices in the face of the dock, the whole space can be filled at high water; and when a vessel is admitted and safely berthed, the supply of water can be cut off, and the sluices of the emptying culverts opened. At intervals, 75 ft. apart, are double flights of stairs leading to the bottom of the dock, and between these are the timber slides arranged for the convenience of letting down the timbers and planks of vessels. They will be also found most convenient for the plates, of iron vessels, and for the many uses that the steps of the dock might interfere with. The head of the dock terminates in one of these slides and stairs, from which the view of this fine work is admirable. As we stated in April, the whole of the facing is of beautifully white Dublin granite, the reflective powers of which will be fouud of the greatest advantage to the shipwrights employed at the lower parts of vessels, more especially in dark winter days.

The entire length in the clear, from inner invert to head of dock, is 400 ft.; the width, above, 80 ft.; and in the bottom, 37 ft. 8 in. The dock is 2 ft. lower in level of copiug than the coping of the entrance, which allows of more light, while the extra height of sea-wall and entrance is to provide against extraordinary spring-tides, which have frequently flooded the quays of Dublin. We will resume this subject at another opportunity, and report progress.

NOTES OF AN AMERICAN TRIP IN JULY, 1858.

(Continued from page 236.)

Amongst the many varied and beautiful applications of machinery to domestic purposes so generally adopted in the United States, few seem more efficient or useful than the machinery for sewing, or, as it is usually termed, the sewing machine.

The most perfect in principle and action that I have yet seen is that with the "lock-stitch," invented, I believe, by Mr. Howe in 1846, and since improved by Wheeler and Wilson, by whose name it is generally known, and whose machine is, I think, nearly perfect.

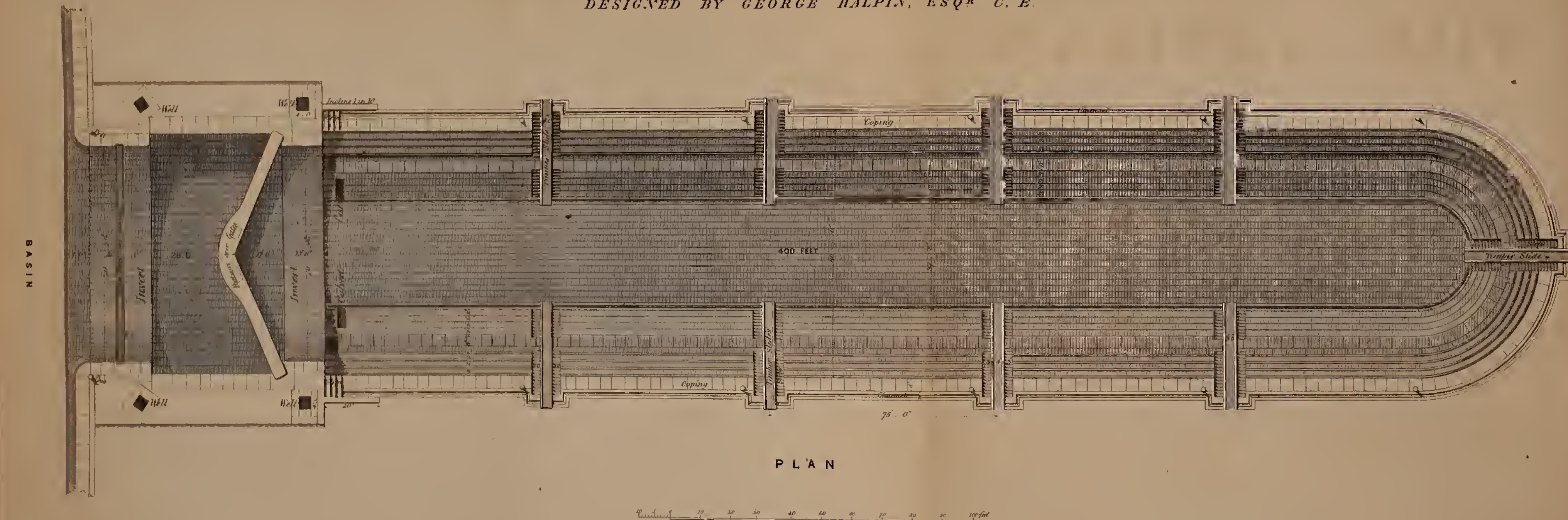
I was surprised to see how numerous they are, having found them in nearly every family I visited, besides having seen them in several factories, set up exclusively to manufacture all descriptions of clothing. In one of these establishments I visited, I found a great number of machines at work, tended by well-dressed decent-looking young women, who were earning, as I was told by the proprietor, from four to six and eight shillings per day, with very little trouble; and he found he was a great gainer, for he ouly kept the best hands, and paid them well, so as to give them an interest in their work—a plan I should strongly recommend to most of our employers in England. He said, with a sly look, on telling me the above—"Guess we cau find *our* women a better job than making shirts at six cents each, and turning out on the streets for a living." Need I say how I, as an Englishman, felt this, and knew that I could not refute it?

These machines are applicable to every variety of sewing, from the lightest muslins to the heaviest cloths, performing equally well upon silk, woollen, linen, and cotton, and gathering, seaming, quilting, felling, hemming, &c.; in fact, performing every style of sewing, except working the button-holes and putting on the buttons.

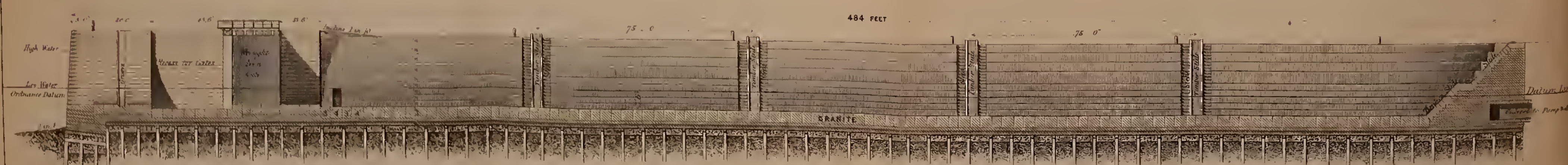
The use of the machine is quickly and easily learned. From my own

NEW CRAVING DOCK IN DUBLIN HARBOUR,

DESIGNED BY GEORGE HALPIN, ESQR C. E.



PLAN



SECTIONAL ELEVATION

W. Smith C.E. delin.

experience during a visit of a couple of hours' duration, an hour is sufficient to make a woman of ordinary intelligence well acquainted with its principles and working. Some of the machines are mounted on a plain table, others have a sort of box cover, whilst most that I saw in private dwellings were in polished mahogany or rosewood cases, forming when closed a handsome piece of furniture, which would, when required, prove of far greater utility than half the gimcracks with which we consider it "necessary" (?) to encumber our rooms.

In using these machines, when not driven by steam, the operator seats her or himself before the small table on which the machine is mounted. By placing the feet on the treddles the machine is easily put into motion. The material to be sewed is placed on the plate below the needle, so as to pass from left to right. The width of the seam is regulated by means of gauges, but I am told that after a little practice they prefer to dispense with them, as the hand and eye soon get sufficiently accurate to render them useless. Two threads are used, one above and one below the fabric, and on moving the treddles up and down, motion is communicated by means of the band to the needle and other working parts of the machine, and the needle, with the thread through the eye near the point, descends through the fabric, so that there is a line of thread upon each side of it. As it rises, the thread upon the right of the needle is slightly looped and seized by the rotating hook, the loop enlarged, and carried around the bobbin containing the lower thread, which it encloses. This loop being drawn up, it draws the lower thread into the fabric, and forms between the two surfaces a firm "lock stitch," and makes a seam much stronger than any hand-sewing whatever. The material to be sewn is moved forward, and the length of the stitch graduated by the feed, at the pleasure of the operator. Three yards of thread is a fair average for a yard of seam. The amount of sewing that an operator can accomplish depends a great deal on the kind of work and her experience. "One thousand stitches per minute are readily made, which would form above a yard of seam, with stitches of medium length." By means of this machine, the wearisome unending task is rendered a healthful pleasing pastime, and the beauty and regularity of the work far surpasses anything that can be done by hand-sewing. In the factory of Messrs. Douglass and Sherwood a day's work of ten hours, for one person by the machine, is estimated at 1,000 yards of straight sewing, in which there will be ten stitches to the inch. The machines used are those making the "lock stitch." I am inclined to think, however, that this estimate is incorrect in respect of its *regular* working.

These machines are made entirely by machinery on the same principle as Colt makes his celebrated revolvers, and any part becoming damaged or broken can be easily replaced at a slight expense, "as thousands of pieces are made precisely similar, and fit each of all the machines." Some I saw which had been at work for five years on shirts and collars appeared as good as new. A machine costs from £20 to £25 according to style. I am glad to see that in Glasgow attention has been directed to them, and that their utility is appreciated sufficiently to induce Dr. Strang to read an interesting paper on them at the late meeting of the British Association at Leeds. No doubt, by and bye, when we in this country find we are *sufficiently far behind* in the present race of competition, and have lost some of the ground we should have held, we shall begin to "see about it," and then "perhaps" something may be done.

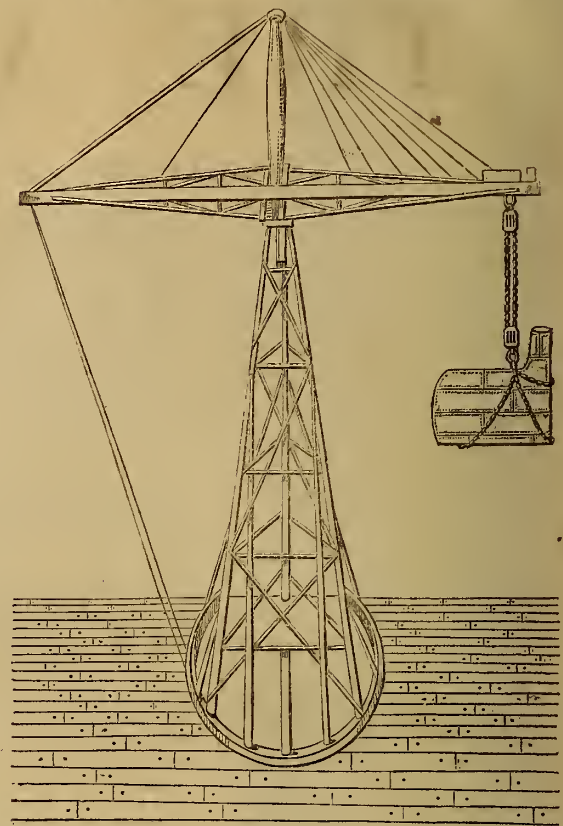
I would conclude these few notes by earnestly recommending our people to keep up the quality of their goods, to look ahead, and get rid of a great deal of their ridiculous prejudice, and not be so wedded to old obsolete ideas in this age of progress, but whenever and wherever better and more efficient means are brought forward to accomplish an end, to be *at least* among the first to adopt them, and thus keep this country in her position of first in the race—not last.

I must, in conclusion, express my thanks for the uniformly polite and attentive manner in which my wishes to see and examine anything were everywhere freely granted in the States, and which formed a pleasing contrast to some of a different nature I have frequently met with in England; and also express my regret that many of my countrymen should think it needful, in their visits to that side of the water, to forget the manners and actions of gentlemen—an occurrence which I was sorry to hear (and in one instance to see) is not at all uncommon, and is frequently bitterly and severely remarked on. I would strongly advise them to learn by heart and, *above all, practice* this bit of advice, "Civility costs nothing." Let us rather meet and treat them as brothers.

BISHOP'S PATENT BOOM DERRICK.

Public attention having been directed to this powerful hoisting apparatus, through the recent launch of an enormous floating derrick from the establishment of the Thames Iron Works and Ship Building Company, at Blackwall, a brief description of the invention, which is of American origin, and of its general application, prior to making its appearance in this country, may prove interesting to our readers.

Whether it be used as a *transportable, stationary,* or *floating* apparatus, the fundamental principles of the boom derrick are precisely the same, and these differ from ordinary derricks, cranes, and similar hoisting machines, inasmuch as, while hitherto the boom destined to sustain the weight to be lifted, projected wholly from *one side* of a mast or standard; in Mr. Bishop's



invention the boom is secured at about the middle of its length to a central mast, or king-post, which turns in appropriate bearings in the upper part of a rigid frame. The rear extremity of the boom is connected by one or more travelling brace-rods with the base of the frame, which is circular in form, and has on its under side a circular rail, upon which run friction wheels, and thus allow the boom to be freely turned.

This arrangement admits of the weight or load being turned in any direction and deposited at any given point within a circle of which the boom forms the radius. The frame, or standard, in which the central mast or king-post is mounted, is of a pyramidal form. When the derrick is not required to lift over two-thirds of its own weight, the base of its frame may be provided with sliding-ways, so as to allow of its being placed on a tramway, and thus transported with facility to any point required. The frame or standard consists of three posts or legs placed equi-distant apart at their base, and united at their upper ends by a triangular cap, into which the king-post descends. These legs are connected together by a series of horizontal ties and diagonal braces; and where the lifting capacity of the derrick requires the arrangement, two side-posts are affixed to each of the three legs as additional supports to the same.

The machinery by which the lifting power is obtained, varies somewhat in its arrangement, according to the specific purposes for which each derrick is required. It may, however, be constructed either for slow or rapid hoisting; or it may combine both, in which latter case the speedy shifting of the gearing is efficiently provided for. Manual labour, steam, horses, or oxen, may be applied as the motive power; and an important feature of the invention, as compared with shears, is, that in all its varied operations, not only the time and cost of setting up guys are wholly avoided, but the requisite space to carry them is dispensed with.

The Transportable Derrick, constructed mainly on the principles above described, was the first kind of boom derrick introduced by the inventor. This machine had its origin in the year 1845, in connection with a sub-contract taken by Mr. Bishop on the works of the celebrated High Bridge, which forms

a part of the aqueduct for conveying the water of the Croton River to supply the city of New York. The resident engineer on that portion of the works, Mr. P. Hastie, has described the operations of this derrick as follows:—"The contractors, Messrs. George Law, Roberts, and Mason, employed Mr. Bishop to frame and put up the trestle-work and centering for the arches. He was thus led to invent and construct a derrick, which so effectually answered his purpose, that the contractors having seen it in operation, determined to use it in laying the arch-stones, spandrels, and other work. Accordingly, Mr. Bishop built *three* of these derricks, which were found to be exceedingly convenient and economical. The machine was considered by all parties a most useful invention. I had the opportunity, almost daily, of seeing the derrick used, and I have never doubted its great utility in the erection of similar work."

The three derricks used at the High Bridge were readily shifted upon a tramway along the entire *façade* of over 1,400 ft.; picking up, hoisting, and depositing the stone in the exact positions required. The height of the hoists was 101 ft. from the chord line to the crown of the arches, and 114 ft. to the parapet of the bridge. The heaviest stones weighed 7 tons, and were usually run up in about one minute by a portable steam-engine used on the works; but in putting up the centering for the arches, as much as 11 tons were hoisted at a time. In proof of the satisfactory results accomplished by these machines at this first trial of their advantages, it may be stated that the contractors have certified the three derricks effected a saving of 38,000 dollars in masons' wages alone.

These transportable derricks obviate all necessity for the erection of that expensive kind of scaffolding to which recourse is had when the stone used for any building is raised by means of "travellers;" while the advantages must be apparent which they present over raising the materials by crabs, that frequently have to be placed upon newly-laid portions of a structure. By means of these derricks, so constructed as to be readily set up or taken down, and placed within the area of a church, town hall, or other public edifice, the entire materials for the building, together with the framework of the roof, may be raised and placed in position. In bu lding the Custom House of Cincinnati, and the Trinity Church at Buffalo, these derricks were used; in the latter case, the arms, or booms, *spanned the entire building, 160 ft. in length.*

In the yards of American shipbuilders these transportable derricks have been found useful labour-saving machines, in hoisting and placing in position the heavy timbers and framework of ships, as well as from the great facility with which they may be applied to masting or dismasting vessels.

The Stationary Derrick, a much larger and more powerful machine than those employed at the High Bridge, was the second step in the development of the invention. The first derrick of this description was erected on the wharf of the Morgan Iron Works, New York, and is of the following dimensions: height from the wharf level to boom, 90 ft.; height to top of king-post, 140 ft.; length of boom, 110 ft.; hoisting power, 75 tons. After seven years' experience, the valuable nature of its services is thus described by the proprietors:—"It is one of the most important features of this establishment, and the facilities which it affords us render it of the most invaluable character. The heaviest hoists—boilers of 50 tons and upwards—are hoisted and placed on board of steamers in *from two to three hours;* and at the same time are hoisted without having recourse to any kind of light joiners' work, the necessary space to lower through being all the preparation required. In erecting engines, the derrick is used for every description of hoist, whether small or large, by which a considerable amount of rigging and labour is saved. The machinery of the derrick, which is very simple, is arranged both for rapid and slow hoists, according to their respective weights."

The great facilities afforded to the lifting operations of the Morgan Iron Works by this machine naturally drew to it the attention of engineers and shipbuilders. Messrs. Stillman, Allen and Co., the eminent marine engineers of the Novelty Works, New York, whose experience has extended to lifts of 58 tons, describe the derrick as "unquestionably a safe, convenient, and expeditious means of raising and placing large weights." Eventually its advantages over shears and cranes were recognised by the Executive of the United States Naval Department, who, convinced of the vast saving the derrick would effect in tackle and labour, together with the important economy of time in masting and dismasting vessels, as well as in the various hoisting operations constantly occurring, entered into a contract with the inventor to take down the shears which had been newly erected at the Brooklyn Naval Yard at a cost of 16,000 dollars, and to erect in their place a stationary derrick of still greater power than that at the Morgan Iron Works. The dimensions of this machine are:—height from the Navy Yard Wharf to booms, 126 ft.; height to top of king-post, 176 ft.; length of boom, 110 ft.; hoisting power, 100 tons. The satisfactory results attending the change have been clearly established in the official report of the Commission appointed by the Navy Department to inspect and test this derrick.

Stationary derricks have been erected, subsequently, in the United States Navy Yard, at Charlestown, Massachusetts; at San Francisco, for Messrs. Howland and Aspinwall's line of Pacific Mail Steamers; and also in the Navy Yard of the Spanish Government, at Havana. These three machines have respectively afforded the utmost satisfaction by their performances; and during the erection of the latter one, many of the officers of the English and French vessels of war then in harbour assured the writer that they were fully convinced of the superiority of the machine over shears. At Havana, as at Brooklyn Navy Yard, the shears which had been put up at a cost of 8,000 dollars were taken down, in order to give place to this derrick, which by far exceeds in capacity and power either of those erected in the United States Navy Yards. The dimensions are:—Height from wharf to boom, 129½ ft.; height to top of king-post, 179½ ft.; length of boom, 120 ft.; and hoisting power, 150 tons.

After having successfully established the merits of the boom derrick, both as a *transportable* and *stationary* weight-raising apparatus, the inventor next directed his attention to the production of a machine about to be described, and adapted to the frequent requirements of the maritime community.

The Floating Derrick, of which a vignette will be found on the engraved title page of The Artizan, issued January, 1858, fulfils on seas, lakes, and rivers, in ports, docks, and harbours, most of the functions performed by transportable and stationary derricks on land, together with others of still greater import—as, for instance, the raising of sunken vessels, and the lighting vessels off shores and over sand bars. These derricks are built in "*scows*," or flat-bottomed vessels, and are either towed to the locality of operation by steam-tugs, or are fitted with engines, and propelled by the screw, or by a series of paddle floats, which will be more particularly described hereafter.

Premising that all the American derricks, whether transportable, stationary, or floating, have, naturally enough, been built of wood, in a timber country whose forests are inexhaustible, we will now give the dimensions, and endeavour to explain the principles which enter into the construction of the wrought-iron floating derrick recently launched from the Thames Iron Works and Shipbuilding Company's premises at Blackwall. The "scow," or vessel, on which the derrick is placed, and into which its standards are built, is of rhomboidal form amidships, for a length of about 95 feet, tapering off, both toward stem and stern, in the shape of two slightly waved-line wedges: so that she is built sharp fore and aft, and carries a rudder at each end, like some of the iron steam-boats which ply above bridge. The length over all, of the vessel is 257 ft., and her breadth amidships, up to where the tapering-off lines begin, is 90 ft. on deck, and 81½ ft. at the bottom, which is perfectly flat.

This enormous pontoon, or hull, which is 12 ft. wider than the *Great Eastern*, is divided throughout her length by an elliptical truss or girder, weighing nearly 70 tons, having a span which approximates to that of the centre arch of Southwark Bridge, and a height of 30 ft. Two smaller arch trusses are placed diagonally across the hull, intersecting the main arch through its centre, and through each other almost at the same point. This arrangement becomes what (to use an osteological illustration) may be termed, the vertebræ of the hull, upon which the ribs are formed by means of the bottom and the side-angled irons. The ground plan of the hull resembles in its subdivisions, on a large scale, the numerous square boxes of a compositor's type "case." The whole hull, from stem to stern, and from deck to keel, is divided into eighty-seven compartments, most of which are 14 ft. square and 14 ft. high. There is a bifold object in this arrangement: firstly, to strengthen the general construction of the hull; and, secondly, to form water-tight compartments throughout *one* of its sides, for the purpose of admitting water-ballast to serve when raising a sunken vessel as a counterpoise to the *other*, into which the derrick proper, or lifting machine, is built. The compartments on this latter side are devoted to the engines and boilers, to the vessel's stores and to the cabins of the officers and crew.

The derrick proper comprises five triangular-shaped legs, formed of 1¼ in. plates of iron, firmly secured together by cross beams and diagonal ties. This structure supports, at a height of 80 ft., the enormous hoisting "boom," which is 120 ft. in length, and 30 ft. in breadth at its broadest part. It is formed of thick plates of iron rivetted together, and when seen from below appears as though one of the Thames steamers had been taken up bodily and placed on the towering structure, into the upper part of which the king-post descends. On the top of this structure is placed a massive bearing with a concave groove

corresponding to the circumference of the "king-post," which having both back and front ends of the boom affixed to it, and being shod with an inverted or convex groove, rests upon the bearing just mentioned, and is enabled to revolve freely upon a number of steel balls, placed between the two grooves. The height of the king-post above the "boom" is 50 ft., and it is surmounted at the top by a huge iron cap weighing 5 tons, to which are attached the brace rods sustaining both ends of the "boom." The total height from the deck to the top of the "king-post" is 130 ft.

The end of the "boom" opposite to that employed in lifting is connected by several travelling "brace-rods" of great strength, with the base of a circular framework of iron, and the end of these rods being provided with friction-wheels, admit of the weight being moved within the range of a circle the radius of which is one-half the length of the "boom." When required to be put into use for raising a sunken ship, the lifting-boom projects over that side of the "scow" or vessel upon which it is erected, and is provided with ten sets of purchase-blocks, each capable of supporting 100 tons. A chain passes over each of these blocks, and is led down the inside of the hollow "king-post," which is 7 ft. in diameter at the height of nearly 100 ft. above the deck, and thence to one of a series of ten powerful "crabs" (each of which possesses a hoisting power of 100 tons), which are placed on the side of the deck opposite to that of the hoisting boom. An aggregate power of 1,000 tons is thus made available upon a sunken ship or other object. In raising a sunken vessel, water is admitted into those compartments of the "scow" which are on the side opposite to that on which the hoisting takes place—thus providing a counterbalance to the accumulating dead weight. From its peculiar construction, the "scow" has a very light draught of water, not exceeding 30 in. When launched, it was necessary to pump 300 tons of water into the hull to keep it sufficiently steady under the weight of its top gearing; but in raising a vessel, the accumulation of strain will, as such vessel approaches to the surface of the water, force the hull down many feet. Within the hold are placed two steam-engines for propelling the vessel, and two others for working the derrick's gear for raising the ships. The huge machine will be moved by means of a revolving chain passing over two wheels placed on each side, and provided with moveable paddles or floats. This chain and its floats revolve in a sort of channel or sewer, nearly 90 ft. in length, protected by the outer iron plates of the vessel's side, and which floats dip below the surface of the water. The floating derrick will carry no sails.

The following are the particulars *en résumé* of the power, dimensions, and weight, of the various parts of this extraordinary machine. The power is—hoisting capacity above the surface of the water, 1,000 tons; gear for working, 10 sets of crabs, independent of each other, worked by two oscillating engines of 30 nominal H.P. each; propelling power, two pair of oscillating engines of 160 H.P. each pair, all fitted with Barran's patent cup-surface boilers. The weight of the scow or hull (without derrick) is 750 tons; of the derrick, including legs, boom, "king-post," casting, and rods, 250 tons; making the total weight of scow and derrick, with boilers, propelling and hoisting machinery, about 1,200 tons. The dimensions are—length over all, 257 ft.; breadth 90, depth 14, height from deck to boom 80, ditto of "king-post" above boom 50, radius of boom 60. This machine is capable of depositing its load anywhere within a circle whose diameter is 120 ft. The measurement of the vessel is 5,000 tons, and the entire cost about £40,000.

Property of the value of £2,000,000 is lost upon our coasts annually, but beyond the rare instances in which a vessel wrecked off the mouth of a river, or at the entrance of a harbour, is raised chiefly through tidal influence, and beyond the piecemeal recovery, by the expensive process of diving, of portions of cargoes sunk in shallow soundings, no efficient means of salvage exists.

It remains to show by the antecedents of the floating derrick that it provides against this state of things. Two instances of its capabilities will suffice for the purpose of these remarks. When the *Ericsson* caloric ship, of 2,300 tons (which it will be recollected was to effect, by means of heated air, a revolution in motive power), was sunk off the Coast of New Jersey on her trial trip, a contracting party essayed to raise her by means of steam pumps. Six of these were applied ineffectually during a period exceeding a month, when a floating derrick, belonging to the New York Company, was brought to operate upon the sunken vessel, recovered her, and, aided by two tug-boats, placed her on shore for repair, within twenty-four hours after the derrick had commenced operations.

The second instance of the application of the derrick is given in the "New York Express," and quoted textually:—"The wonderful power and usefulness of this great machine have been again successfully tested. It is now, as we write, passing the Battery, with the steamer *Splendid* hanging in the chains suspended from the boom of the derrick. The *Splendid* is in length 176 ft. She was sunk opposite West Point, on the Hudson River, by a barge running into her at night, and knocking a hole in her bottom. The derrick raised her in about an hour after the chains were placed; and with the aid of two tug-boats, the steamer and derrick were towed to this city."

In various parts of the United States sixteen of these derricks—transportable, stationary, and floating—have been constructed, and worked for several years, to the entire satisfaction of the owners. The merits of the machine, therefore, have been fully tested, and it is now introduced into this country by means of a company formed under the Limited Liability Act, called the Patent Derrick Company.

Submarine salvage operations, by means of floating derricks, will, we are informed, constitute the chief feature of the Company's business; and the directors are prepared to grant licences under patents, embracing nearly the whole of Europe, for the erection of transportable or stationary derricks in Government arsenals and navy yards; also to dock companies, shipbuilders, engineers, contractors, and others.

BRITISH ASSOCIATION.—LEEDS MEETING, 1858.

Section G: Mechanical Science.

The following is the Inaugural address "On the Progress of Mechanical Science," delivered before the Mechanical Section of the British Association, by William Fairbairn, F.R.S., President of the Section:—

In opening the business of this section of the British Association, I have to congratulate you upon the encouraging prospects which our meeting in this great mart of industry is calculated to afford. This large and important district is only just recovering from a state of intense excitement and a burst of loyalty that have reverberated from one extremity of the Riding to the other. In these rejoicings I have naturally taken a deep interest, and now that the royal visit is over, a meeting for the extension of science and useful art is probably the most appropriate conclusion of the festivities which have occupied the attention of this town for the last two weeks.

On a former occasion, when I had the honour of occupying the chair of this section, I endeavoured to combine in a condensed form such improvements in mechanical science as had been effected during the successive intervals between the annual meetings of this association, and conceiving that a short account of what has taken place during the last few years may not be unacceptable, I have on this, as on previous occasions, ventured to direct your attention to a succinct retrospect of what I consider new and valuable in mechanical art.

In mechanical science and general engineering this country continues to maintain its high position in new developments and continued progress; and the almost innumerable patents weekly taken out under the new law, are remarkable indications of the activity and inventive power of the country. It is not yet thirty years since the introduction of malleable iron as a material for shipbuilding, and a much shorter time has elapsed since it was first applied to the construction of bridges. We have all of us heard of the tubular system so successfully applied to the bridges across the Conway and Menai Straits, and now it is extensively employed in every quarter of the globe. There is no span within the limit of 1,000 ft., but which might be compassed by the hollow-girder bridge with security and effect. These discoveries are of immense importance to mankind, and where they are carried out with skill and a strict adherence to sound principles of economy and science, they give to the engineer of the present day a power which in former times it was impossible to realise.

Steam Navigation.—In this department of practical science, although much has been done, yet much remains to be accomplished in giving to the iron ship uniformity of strength and security of construction. In vessels of such complex form, bounded by such a variety of curved surfaces, we are yet much at sea as to the precise points of application of the material, in order to attain the maximum of strength combined with lightness and economy. These are data yet to be ascertained, and it will require long and laborious experimental research before the facts are clearly known and established. Much has, however, been accomplished in the absence of these data, and I may safely refer to that noble structure the *Leviathan*, which, with all her misfortunes, is, nevertheless, a most magnificent specimen of naval architecture. The cellular system, so judiciously introduced by Mr. Brunel, is her great source of strength; and I am persuaded that she will stand the test (which I have recommended in other cases) of being suspended upon the two extreme points of stem and stern, with all her machinery on board. Or, these conditions being reversed, I believe she may be poised upon a point at her middle, like a scale-beam, without fracture or injury to the material of which she is composed. Her cellular construction and double sheathing round the hull, and the same formation on the upper deck, give to the vessel enormous powers of resistance; and her division and subdivision by bulkheads ensure a large margin of security, in whatever circumstances she may be placed. In fact, she may be considered as a large hollow girder, requiring a load of nearly 10,000 tons suspended from the centre to break her. I mention this to show that her want of success is not due to any want of success in the ship herself, but to the magnitude of the speculation as a commercial transaction, and her unmanageable character in regard to the shipment of cargo, and similar difficulties which she may be called upon to encounter. I hope, however, that the necessary funds will be forthcoming, and that we shall yet see her dashing aside the surge of the Atlantic at a speed of eighteen or twenty knots an hour.

Railways.—The magnitude of this great republic (as it is called) of speculation and industry is scarcely, if ever, appreciated by the public. We look at the locomotive of the present day, or glide by its means over the surface of the earth, without once thinking of the amount of skill and of capital expended in the production of such vast and important results. At the present moment we learn, from returns recently published, that we have in this country alone 9,500 miles of railway executed and in actual operation. And, taking at a rough calculation one locomotive engine of 200 horses power to every three miles of railway, and assuming each to run 120 miles a day, we thence calculate the distance travelled over by railway trains to be equal to 380,000 miles per day, or the enormous distance of 138,000,000 of miles per annum, a space measuring the distance of the planets, and beyond the conception of those not conversant with figures. To transport engines and trains this distance, requires a force equivalent to that of upwards of two hundred thousand horses in constant operation throughout the year.

As regards the commercial value of railways, it will not be necessary to enlarge upon it in this place. Suffice it to observe that a clear revenue of £12,000,000 is left, after all expenses are paid, for distribution amongst shareholders and creditors. This amounts to $3\frac{3}{4}$ per cent. per annum—a small return upon £320,000,000, the original cost of 9,500 miles of railway, an average of £34,000 per mile.

In the locomotive engine there has been no improvement of importance during the last two years, excepting only its adaptation to burning coal instead of coke, without the production of smoke. To a certain extent this has been successfully accomplished, but the process is still far from perfect. Superior training is wanting for engineers and stokers before we can look forward with certainty to the time when the use of coal will become general, with increased economy and with the suppression of the nuisance of smoke.

In the formation of the permanent way, considerable improvements have been effected, especially in the jointing of the rails by what is termed the fish-joint, which secures a more perfect union of the rails, produces a smoother surface, and diminishes the wear and tear of the rolling stock, when compared with the old system of jointing, so sensibly felt in carriages running over the line at great velocities.

Manufactures.—For the last twelve months, great depression has existed in this department of the national industry, and notwithstanding the attempts to cheapen the production of the staple articles of manufacture by the introduction of improved machinery, there still exists a considerable depression in many of the great marts of industry. This is probably to be attributed to the disturbed state of India and China, but looking at the native activity of the manufacturing population, and the amount of capital employed, there has been no serious diminution in the production of manufactured articles, nor any stagnation in the demand for labour. On the contrary, I believe, with the exception of the causes just alluded to, that the manufactures of this country were never in a more flourishing condition.

In the iron trade, with which this section is more immediately connected, there has been a similar but slight depression, the manufacture of pigs, plates, and bars, being as great as in any former year; and taking into account the improved process by which malleable iron and steel is now produced, there is reason to hope for a greatly increased demand and an enlarged production. In fact, such have been the improvements since Mr. Bessemer first announced his new process of boiling the crude iron direct from the smelting furnace, and dispensing with the puddling process, that we appear to be now in a state of transition from the old system of smelting, refining, and puddling, to a more direct, continuous, and improved process of manufacture.

Steel bars and plates are now made without the intervention of an intermediate and tedious process, and we may reasonably look forward to the introduction of an entirely new article of manufacture of greatly increased powers of resistance to strain. Although, hitherto, Mr. Bessemer has not succeeded in producing malleable iron by his new process, he has made beautiful refined iron, and has stimulated others to attempts at improvement in the same direction. His discoveries, first given to the world through this section of the British Association, have already proved of great value to the community, and we look forward with confidence to the introduction of still greater improvements—improvements by which steel plates and bars will be produced at almost the same price as we can now obtain the best manufactured iron.

The Machinery of Agriculture.—This is a branch of mechanical art which requires the careful consideration of the mechanician and the engineer. The time appears to have arrived when the introduction of machinery, combined with the wide diffusion of education amongst our agricultural population, is absolutely necessary; and in my opinion, increased intelligence, together with new machinery, will double the production of the soil and improve the climate in which we live. Much as has already been done, very much has yet to be accomplished; we must persevere in the new processes of deep draining and subsoil ploughing, and in the substitution of steam power in place of horse and manual labour, before we can realise such large and important advantages as are now before us. Great changes and improvements have been effected in my own time, by the introduction of new implements to relieve the labours of the farm. Everything cannot, however, be done by the mechanician and engineer; much has to be done by the farmer in the preparation of the land to render it suitable for machine culture; and a willing heart as well as a steady hand is required of the agriculturist before he can work in concert with the engineer. The reaping machine has now attained such a degree of perfection as to bring it into general use on lands prepared for its reception, and the steam plough is making rapid strides towards perfection, and is likely to take the place of horses, and effect a change as beneficial to the farmer as it will be advantageous to the public at large.

Electric Telegraphs.—The consummation of telegraphic communication between the old and new worlds is the crowning triumph of the age, and I hail, in common with every lover of science, the immense benefits which the successful laying of the Atlantic cable is calculated to secure for mankind. It is another step forwards in the great march of civilization, and the time is not far distant when we shall see individuals as well as nations united in social intercourse through the medium of the slender wire and the electric current. These are blessings which the most sanguine philosophers of the past never dreamt of. They are the realization of the age in which we live; and I have to congratulate the section on what has already been done, and upon the benefits yet in store for us in the wide, and to some extent, unexplored field of this wonderful discovery.

ON THE COLLAPSE OF GLASS GLOBES AND CYLINDERS.

(*Interim Report.*)

By W. Fairbairn, Esq., F.R.S.

At the meeting of the British Association last year, a Paper was read upon the collapse of cylindrical wrought-iron tubes by an uniform external force. These experiments upon a ductile and fibrous material led to some novel and important results, and suggested the propriety of similarly testing the resisting powers of a perfectly homogeneous, crystalline, and rigid material, in order that our knowledge of the laws which govern the resistance of vessels to collapse might be confirmed and extended.

The experiments were conducted in a similar manner to those upon iron. Some glass cylinders and globes were procured from the glass-house, and hermetically sealed by the blow-pipe. They were then placed in a strong wrought-iron vessel, connected with a hydraulic force-pump. As the pressure rose in pumping in water, it was recorded by a Schaeffer gauge. The point of rupture was indicated by an explosion in the vessel, and by the sudden decrease of the pressure.

Strength of Flint Glass Globes to resist an Uniform External Force.

Mark.	Diameters.		Thickness.	Pressure of Collapse in lbs. per sq. in.
	in.	in.	in.	
L	5·05	4·76	0·015	292
M	5·08	4·70	0·019	410
K	4·95	4·72	0·021	470
B	5 60	..	0·020	475
N	8·22	7·45	0·010	35
C	8·20	7·30	0·012	42
D	8·20	7·40	0·015	60

It will be seen that, notwithstanding the extreme thinness of the glass, the pressures range as high as 475 lbs. per square inch over the entire surface. This enormous pressure is equivalent to a load of 20 tons distributed over the $5\frac{1}{2}$-in. globe of only 1-50th of an inch thick of glass.

Unfortunately, the 8-in. globes were elliptical to a serious extent, and hence in these the collapsing pressure was greatly reduced, ranging from 35 lbs. to 60 lbs. per square inch of surface.

The next results are upon glass cylinders, blown with hemispherical ends. In the experiments upon iron the remarkable law had been deduced, that the strength of cylindrical vessels exposed to a uniform external pressure varied *inversely as the lengths.* Thus with cylinders similar in other respects, one twice the length of another collapsed with one-half the pressure; one three times as long, with one-third the pressure, and similarly in all cases. From the following experiments it will be seen that the same law applies in the case of homogeneous cylinders of glass:—

Strength of Glass Cylinders to resist a Uniform External Pressure.

Mark.	Diameter.	Length.	Thickness.	Collapsing Pressure per square in.
	in.	in.	in.	
E	4·06	$13\frac{3}{4}$	·045	180
G	4·02	14	·065	297
H	3·98	14	·076	382
P	4·05	7	·046	380
Q	4·05	7	·034	202
T	3·09	14	·024	85
R	3·08	14	·032	103
S	3·25	14	·042	175

These cylinders, though of high resisting powers, sustain a considerably less pressure than the globes. Comparing cylinders E and P, 14 and 7 inches long respectively, and nearly similar in diameter and thickness, we find the longer was crushed with rather less than half the pressure which was required to collapse the shorter cylinder, which is a confirmation of the law deduced from iron tubes.

The general formula for the globes is of the form of the following equation:—

$$P = \frac{C \times t^{\frac{3}{2}}}{D^{3 \cdot 17}} \quad . \ . \ . \ . \ (1.)$$

P being the collapsing pressure, D = diameter, t = thickness of glass.

Similarly, putting L = length of cylinder, the formula deduced from Table II. is of the form—

$$P = \frac{C \times t^{\frac{3}{2}}}{D \times L} \quad . \ . \ . \ . \ (2.)$$

which is similar to that for iron tubes.

ON THE PERFORMANCE OF STEAM VESSELS,

THE FUNCTIONS OF THE SCREW, AND THE RELATIONS OF ITS DIAMETER AND PITCH TO THE FORM OF THE VESSEL.

By Vice-Admiral Moorsom.

At the Meeting of the Association in Dublin last year, a Memorandum "On the Want of Facts respecting the Performance of Vessels at Sea," led to the nomination of a committee, the objects and functions of which do not appear to have been clearly defined, and the result is that the committee has never met.

In order in some degree to remedy this failure, I propose now to furnish the Association with such further information on the performance of vessels at the *measured mile*, as may induce them to appoint a committee with the specific object of procuring experiments to be made *at sea*, the records of which shall be kept in such form as will enable competent persons to calculate from them the characteristics of vessels, engines, and screw propellers, so that the performance of each may be duly apportioned.

This is what I have been in the habit of doing for myself, whenever I could obtain the requisite facts; but, as I have before stated, my cases are not such as to justify at present the induction of general laws.

I regret that other engagements at the time when the meeting of the Association is to be held will prevent my being present to take part in the discussions. I will endeavour to make my statements such that the want of personal explanation may not defeat my object.

In the pamphlet which accompanied my former memorandum, and which was also embodied in the Appendix to the Report of the "Shipping Registration Committee," I showed the method of analysis by which I have been in the habit of testing the performance of vessels, engines, and machinery; and I gave in a Table the particulars and results of eight vessels, of which four were paddle and four screw. I stated that this method was purely empirical, the result of observation and experience.

I have not yet met with a method which comes nearer the truth. I believe that experiments at sea may lead to the discovery of a better method.

To this Paper are appended Forms of Returns intended to further this object.

Considering the formula $R = A\ W \times \frac{V^2}{2g}$ to be the foundation of all sound induction on the question of resistances, I consider also that at present its limit of application is to the mid-section only, irrespective of hull, masts, and rigging, and to the resistance in smooth water with calm weather.

Addressing, as I am, a scientific body, it is unnecessary to explain the terms of this formula; they are well known.

But it may not be so well known that there are modifications of this equation to meet the increased resistance arising from hull, masts, and rigging, wind and sea, and the form of the vessel.

But these modifications embrace only a very small range of the additional elements, because no properly conducted experiments have been made under varied conditions *at sea*.

The resistances of sections which have come within my observation are comprised within the expressions—

$$R = \frac{S\ V^2}{3582} \text{ and } \frac{S\ V^2}{3219}$$

and the specific resistances due to the forms of vessels lie within 6 and 13 per cent. of R.

It is not convenient that in a Paper like this, argument should be adduced in support of any proposition; it would occupy too much space and time. I must be content to appear dogmatical, and must use illustration in support of assertion.

In the memorandum of last year, reference was made to experiments with the *Rattler* in Yarmouth Roads, in 1845, when the *thrust* of the screw was sought to be measured by a dynamometer, and I showed that the results were inconsistent with each other and with other trials in the Thames.

The *thrust*, as indicated by the dynamometer, did not measure the specific resistance of the vessel, which it ought to do; moreover, the proportions of the screw were not adjusted to the form of the *Rattler*, and the slip was greater than a properly balanced screw would have made.

In support of this opinion, I may state the results of performance at the measured mile of the Duke of Sutherland's yacht *Undine*, in July, 1856, and July, 1858:—

	1856.		1858.	
	Ft.	In.	Ft.	In.
Screw diameter	6	6	7	10
,, pitch	11	0	11	3
,, length	1	4	1	4
Draft forward	8	3	8	6
,, aft	11	3	11	10
	Sq. Ft.		Sq. Ft.	
Mid section	148		154	
Indicator H.P.	162		157	
	Knots.		Knots.	
Speed	8·60		9·26	
Number of revolutions	108·00		101·74	
Slip per cent.	26·52		17·9	

Now, the first observation that may be made is, that the larger diameter of course produced a greater thrust, and so a better result. But this does not follow.

It will be observed that the pitch is considerably less in proportion to the diameter in the new screw.

The proportions are not exactly what I wished, but sufficiently near, and the point of the case is, that the slip was calculated beforehand, and was given to Lord Stafford a fortnight before the trial as "about 17¾."

It will be seen that the mean average at the trials was 17·9 per cent. On the same grounds, then, that I calculated the slip of the *Undine*, I have expressed the opinion respecting the *Rattler*.

The mean of five trials in Yarmouth Roads, under favourable conditions, gives a slip of 15·798 per cent. when the *Rattler's* draft of water was about 12 ft. 4 in., her section 300 sq. ft., and speed 8·8 knots. A trial in the Thames, in October, 1851, with a mean draft of 13 ft. 9½ in., a section of 338 sq. ft., and a speed of 9·141 knots, gives a slip of 17·18 per cent.

The screw, duly adjusted to the form of the *Rattler*, would make a slip of about 12 per cent.

A trial will probably be made, in time to be stated to the Association, of Lord Dufferin's yacht *Erminia*, the results of which will test, even better than the *Undine*, the data on which these remarks on the slip are founded.

This vessel, built from a design of Fincham for the late Lord Ellesmere, became the property of Lord Dufferin, who was desirous of having engine power in her sufficient for a speed of five knots under ordinary circumstances.

After many abortive negociations, Lord Dufferin decided on having non-condensing engines, which Mr. M'Connell designed in consultation with me, and I undertook to give the proportions of the screw.

The following extract from my letter to his lordship, of 3rd August, will explain my views:—

"The draft being, say 9 ft. and 12 ft. respectively, and the section about 137 sq. ft., the vessel will require about 90 H.P. for a speed of 6 knots in smooth water. The engines may work up higher, but 80 to 90 H.P. will comply with your conditions. The screw being 8 ft. diameter, and 13 ft. pitch, will, at the above speed of vessel, give out a thrust of about one-half more than the resistance, provided a continuous disc be maintained. The space between the stern and rudder posts not admitting of a wider blade, it is only about 1-9th of the periphery, instead of 1-6th, the usual proportions; and, therefore, I am in doubt about the thrust, and for this reason I selected a coarser pitch than I should otherwise have preferred, at the risk of having an excess of thrust which may never be wanted. But, supposing the disc to be formed by the rotation of the periphery at about 1,500 ft. per minute, then the slip will be about 21 per cent.

"I am desirous of recording these estimates now, rough as they are, in order that the trial may test the data on which they are based."

This vessel, whose length is about four times her breadth, displacement about 228 tons, and ratio of resistance between 10 and 11 per cent. of that due to her section of 137 sq. ft., is not adapted to a screw, and I advised that she should be lengthened 25 ft., so as to make her length about five times the breadth. There were, however, reasons against that course, and nothing remained but to run the risk of some failure.

The conflicting opinions on the best means of meeting the requirements of this case are instructive. For example: a great authority proposed that the diameter of the screw should be 4 ft., with a pitch also of 4 ft. The resultant thrust of this screw would be one-fourth of the resistance of the vessel at 6 knots in smooth water. There is no amount of pitch that would produce the required thrust to balance the resistance in this case.

A screw of 4 ft. diameter and 4 ft. pitch would twirl round like a teetotum, and with about as much useful effect.

The nature of the slip of the screw may be illustrated by the apparent effect upon it when the vessel is moving in a tideway.

Out of the seven trips made by the *Undine* at the measured mile, I select the two of greatest extremes, viz.:—

	Against tide.		With tide.
	Knots.		Knots.
Speed of screw	10·94	....	10·64
Do. vessel	7·32	....	10·24
Slip per cent.	33·09	....	3·76
Revolutions	98·61	....	95·89
Indicator H.P.	146·32	....	131·64

The mean rate of the tide, therefore, was about 1·46 knots, the speed of the vessel *through the water* about 8·78 knots, and the mean slip about 18·42 per cent. To be accurate, these figures should be interpolated on a decreasing series for the tide past half-ebb; but such minuteness is not necessary, and in this case the correction would be hardly appreciable. From these data may be deduced the following relations, viz.:—

That the *direct* thrust of the screw *against* the tide is 6,877 lbs., and the resultant 4,429, and the slip, being the difference of the ratio of the square roots of these quantities, is therefore 19·75 per cent.

That the *direct* thrust *with* the tide is 6,498 lbs., and the *resultant*, as before, 4,429; the slip is 17·44 per cent.

The mean slip is, consequently, 18·59, which is sufficiently near the former calculation of 18·42.

A further deduction is—that the *resultant*, 4,429 lbs., is at least equal to, or greater than, the specific resistance; for, if not, the slip would not have approached so close to the theoretic ratio which I have before stated was calculated before the trial took place.

This principle of the slip may be used to correct the speed of the *Undine* in her run from Holyhead to the Mull of Cantire, when with smooth water and light airs she had the tide with her the greater part of the time.

The results were as under, viz.:—

Indicator H.P.	158·77	
Revolutions	98·40	
Speed of vessel	9·97	knots (by land).
Do. screw	11·06	
Slip	9·24	per cent.

Assuming the standard ratio of slip, as before determined, at about 18 per cent., the tide appears to have advanced the speed of the vessel about a mean rate of 0·87 of a knot per hour, and therefore reducing the speed through the water to 9·1 knots, or 0·16 of a knot slower than at the measured mile, the indicator H.P. being 1·68 greater.

The *Undine* was, I believe, deeper in the water on this last occasion.

To be accurate, the mean rate of 0·87 would require a small correction, the tide being ebb on a rate increasing from 0·49 to 1·6 knots, as shown by the successive ratios of slip, but not in equal times, of 13·6, 10·94, and 3·18 per cent., as the *Undine* proceeded on her course.

I will endeavour to make my views on thrust and resistance intelligible by assuming a case of a frigate of 300 ft. length, 50 ft. breadth at the water-line, and of a draft forward of 21 ft., and aft of 23 ft., her section being 825 sq. ft., and displacement about 5,185 tons. The speed of such a vessel, with 3,000 H.P., would probably be, at the measured mile in sea-water under favourable conditions, nearly 14 knots; at 14 knots her specific resistance would be about 42,000 lbs., and it may be convenient to take this, in the first instance, as the measure of the *thrust* of the screw.

I will first show the effect of the largest diameter which is compatible with the draft of water of 23 ft., so that the periphery in its rotation may, as far as immersion is concerned, preserve a continuous disc, the blade being supposed to be of the ordinary width. This diameter is about 18 ft. The pitch will be about 17 ft., the effective pitch about 15½ ft., and the slip about 9 per cent. The speed of the screw will be about 15½ knots, and the number of revolutions 91¼.

But ships are not always in a calm, with the sea like a mill-pond. Let the wind rise, and the sea get up, till the resistance is doubled, when the speed will be reduced to about 7 knots.

The resultant thrust at that speed, with the engines continuing to exert the same power, would be about 1-8th of the resistance.

The blades would fly round, and the slip be like that of the driving-wheel of a locomotive engine on a greasy rail.

The pitch is too fine. It is suitable for a vessel whose specific resistance is less than six per cent. of that due to her section; but not for our frigate, whose resistance is about 8 per cent. No practicable amount of pitch would give the required thrust of 84,000 lbs., at a speed of 7 knots, with a H.P. of 3,000.

It is evident that the limit of the pitch of a screw must be sought, if other considerations are set aside, in the space it is expedient to allow between the stern-post and rudder-post.

Assuming that in this case a pitch may be obtained about twice the diameter, or say 38½ ft., it can be shown that the *resultant thrust* will be about 53,000 lbs., or 25 per cent. above the resistance in a calm, but the slip would be about 32 per cent., the speed of the vessel under that resistance being about 11¼ knots.

Other considerations, in addition to the excessive slip, render this pitch altogether inexpedient. We must try further.

At a speed of about 12½ knots under 3,000 H.P., the resistance will be about 47,000 lbs., and the pitch, to give an equivalent thrust, is about 25½ ft., the effective pitch being about 21 ft., and the slip about 17 per cent., the speed of screw being about 15 knots, and the number of revolutions nearly 60.

The screw of 18 ft. diameter has however been, as yet, considered as acting in smooth water only, and its periphery sufficiently immersed.

This will not be the case *at sea*, where there being always some *swell*, the screw will approach too near the surface in its rotation, the disc will be broken, its thrust disturbed, and calculation set at nought.

Let us, therefore, see the results of a diameter of 17 ft., with a *thrust* of about 47,000 lbs., at 12½ knots for the vessel's speed. The pitch must be about 27¾ ft., the effective pitch will be about 21¾, and the slip about 22 per cent., the speed of screw about 15¾ knots, and the number of revolutions about 58.

The comparative results of the screw at 18 ft. diameter with that of 17 ft., the speed of the vessel being 12½ knots, are as follows, viz.:—

		18 ft. Diameter.	17 ft. Diameter.
Periphery		62·000	60·166
Pitch		25·486	27·719
Effective pitch		21·181	21·835
No. of revolutions		59·843	58·051
Thrust	Direct	67907·5	75587·0
	Resultant	46904·6	46904·6
Speed	Vessel	1267·55	1267·55
	Screw	1525·2	1609·1
Slip per cent.		16·891	21·226
Speed of periphery in feet per minute		3383·6	3099·9

Now this screw of 17 ft. diameter will at 14 knots produce a thrust about 42 per cent. greater than the specific resistance in smooth water and calm weather, and therefore the pitch may be reduced, and consequently the slip, if it should be considered that such excess of thrust is undesirable.

In that case, whenever the specific resistance might rise beyond about 47,000 lbs., the speed of vessel would fall below 12½ knots, and the slip would be increased *above* 22 per cent.

The screw of 17 ft. diameter is preferable to that of larger diameter, notwithstanding the greater rate of slip, chiefly because it secures, under ordinary circumstances *at sea*, the maintenance of a continuous disc with the ordinary width of blade, the rate of rotation of its periphery being more than 3,000 ft. per minute.

There are other advantages incidental to the screw of smaller diameter, such for instance as being less exposed to be *fouled* by rigging shot away in action, by less weight, by less strain on the engines and the ship, on which I need not dilate.

PROPOSED FORM OF TABULAR RETURN OF PARTICULARS AND PERFORMANCES OF H.M. SHIPS, *sent to the First Lord of the Admiralty, 1st December*, 1857, *and again 3rd May*, 1858.

TABLE No. I.

Name.	Load Water Line.					Straight of Breadth.		Mid-Section.		Displacement in Tons.
	Length.	Breadth.	Mean Draft ex. Keel.	Angles. Entrance.	Angles. Run.	Vertical.	Longitudinal.	Area in square feet.	Position as to middle of length.	

TABLE No. II.

Name of Maker.	Cylinders.				Mean Pressure.		Weight per sq. in. on Safety Valve.	Barometer Index.	Hydrometer Index.	Nominal H.P.	Area of Heating Surface.		No. of Boilers.	Propeller.							
	Diameter.	Length of Stroke.	No.	Revolutions per Minute.	On Piston, in lbs. per sq. in.	In Boiler in lbs. per sq. in.					Tubes.	Furnaces.		Diameter.	Pitch.	Length.	Angle of Spiral.	Effective Area of Disc.	Revolutions per Minute.	Resultant Thrust by Dynamometer.	Immersion at Draft given in Table 1.

TABLE No. III.

Under Steam.								Under Sail.									
Speed in Statute Miles per Hour.				Consumption of Coal in lbs. per hour.		Indicator H. P. giving the speed as before, when		Speed in Statute Miles per hour.		Area of Sail set in square feet.	Angle of Wind with Yards.	Angle of Yards with Ship's Course.	Angle of Heeling.	Wind.		Sea.	
Trial in Smooth Water. Vessel.	Trial in Smooth Water. Propeller.	Ordinary at Sea. Vessel.	Ordinary at Sea. Propeller.	Trial in Smooth Water.	Ordinary at Sea.	Trial in Smooth Water.	Ordinary at Sea.	Trial in Smooth Water.	Ordinary at Sea.					Direction.	Force.	Direction.	Force.

I will now draw another comparison of the performance of vessel, engines, and screw.

The power exerted being 99,000,000 lbs., at 1 ft. per minute, and the speed 1267·55 ft. per minute, the effective power, or resistance, is 78,103 lbs.

But this resistance is composed of—1st, the specific resistance of the vessel; 2nd, the difference between the power on the piston divided by the speed of screw and the speed of vessel, or the equivalent of the slip in lbs.; 3rd, the aggregate in lbs., at the speed of vessel, of back-pressure from imperfect vacuum, and from friction of machinery, or, in other words, the resultant of absorbed power. The analysis of the total resistance of 78,103 lbs. is as follows, viz.:—

	18 ft. Diameter.		17 ft. Diameter.
Specific resistance	46904·60	....	46904·60
Equivalent of slip	13193·48	....	16578·00
Resultant of absorbed power	18004·92	....	14620·40
Total	78103·00		78103·00

It is by comparisons such as this and the former that I have been accustomed to test the qualities of vessels, engines, and machinery.

These figures must not, however, be taken as absolute quantities; they are but rough approximations.

Those who may have given their attention to the course of reasoning I have endeavoured to carry on by means of these examples, will not fail to perceive that the following questions arise for solution by means of the experiments which it is my object to procure to be conducted *at sea*.

In any given vessel, what relations obtain between the resistance due to her section in smooth water and calm weather, and the resistances the vessel herself experiences under various conditions, when under sail, under the screw, and under both?

What are the relations in any given engine of absorbed power at different speeds?

In any given screw, what are the relations between its *length* and its speed of rotation, so that a continuous disc shall be maintained, and what immersion in relation to the diameter is necessary to the result?

What are the relations between the direct thrust of any given disc and its *resultant*, and the consequent effective area and pitch and ratio of slip?

The professional members of the British Association must be familiar with the functions of the screw, and they may find nothing new in what I have advanced. But I cannot help thinking that a method of investigation is here opened to trial and criticism, from which important results may flow.

I may be told here, as I have been told elsewhere, that no measure can be obtained of a ship's resistance that is to be depended on. I have lived long enough to be entitled to say, that I cannot subscribe to any such doctrine. I have had to encounter, and have overcome, similar difficulties.

Let a committee of competent persons undertake the task with a single eye and an earnest purpose, and difficulties will disappear.

I have no intention of dogmatising; but what I perceive clearly, I may be allowed to express strongly.

As a sea officer, I have performed my part, and I may invite others to do theirs.

Let what I have here indicated be proved or disproved.

I may perhaps be permitted to make a suggestion respecting the composition of the proposed committee.

All experience of public affairs shows the extreme difficulty of effecting any improvement by interference from *without*.

Since last October, I have been in communication with the two First Lords who have held office at the Admiralty in that period, for the purpose of procuring information respecting the performance of the vessels of the Royal Navy, to be laid before the British Association, and of carrying on experiments which may test the issues I have raised.

I have, I hope, imparted equivalent information to that which I have received, but with what, or whether any, effect I know not, and I am precluded from making public any particulars. A committee may, perhaps, successfully follow up what I have begun.

Wherefore, I urge that, besides scientific and practical men, there should be on the committee some who carry political weight and influence, without whom the soft whispers of science will scarcely get a hearing in quarters where the greatest results *might* be accomplished.

It may be amusing if I describe how it was that, some years ago, I commenced these investigations into the functions of the screw.

My attention was drawn to the mode in which fish use their tail as a propeller, to the difference of action in the vertical and horizontal lobes, to the homocircal and heterocircal forks; and I found that fish of great speed possess a large area of tail, capable of expansion and collapse, with a small girth of body (*mid-section*) and elongated head and shoulders; whereas fish of slow motion have a tail of less comparative area, not forked, with considerable girth of body and a bluff head.

Endeavouring to resolve the stroke of which each of these types is capable into the *resultant* in the direction of motion, I perceived that this element was analogous to the pitch of the screw, and governed by an angle of similar relations: in other words, the fish of great speed, with its fine form, small section, large area of expanding tail moved by elongated muscles, possesses an instrument similar to the screw with large diameter and *fine* pitch; while the fish of slow motion, with bluff form, section as large, or larger, than its unforcated tail, like a half-unfolded fan, moved by short contracted muscles, has an implement like a screw with small diameter and a *coarse* pitch.

Satisfied on these points, I proceeded to disintegrate the elements of every screw of whose performances I could procure authentic facts.

That is to say, in any given thrust I found how much is due to the diameter and how much to the pitch of the screw, what the *thrust* and what the *resultant* thrust were, and so the ratio of the slip.

The result is now before the British Association.

Researches of this nature, if carefully conducted, will show that the screw is capable of more accurate application, and more extended use, than has yet been made of it.

Its slip is a calculable element, provided the periphery be so immersed and the rotation such that a continuous disc is maintained.

The limits of immersion and rotation are yet to be determined.

R. BODMER'S IMPROVED SAFETY VALVE.

Mr. Bodmer has invented an improved safety-valve, which has been thought very well of by several of the leading engineers, and as the very frequent occurrence of steam-boiler explosions has pointed out the necessity for an improved safety-valve, we have given the accompanying illustrations, and the inventor's description of his valve is as follows:—

"It is a well-known fact that safety-valves of the ordinary construction, *i. e.*, those where the steam which is about to blow off has at the same time to raise the valve from its seating, will scarcely ever open to a greater extent than

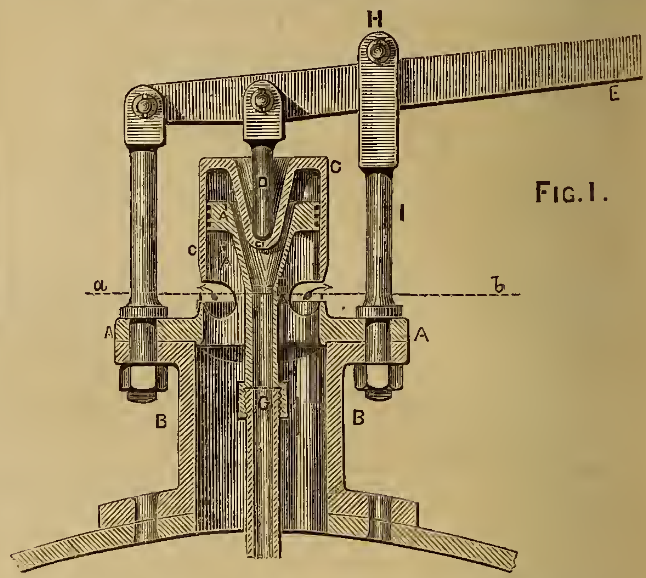


FIG. I.

1-16th in., owing to the instantaneous reduction of the pressure of the steam at the moment of the communication with the atmosphere being established. In fact, the ordinary valve acts simply as an indicator, and not as a safety-valve.

"In order to remedy this serious defect, the improved safety-valve is so constructed that the water or steam, at the undiminished boiler pressure, penetrates through an independent tube under and raises the valve the moment the pressure of the steam in the boiler is in excess of the normal pressure.

"Fig. 1 represents the safety-valve in vertical section, and Fig. 2 is a ground plan of the same in section through the line *a b*, Fig. I.

"The plate, A, forming the valve seating, is cast of one piece with the piston, A_1, the feathers, A_2, and the tube, A^3, and fixed upon the saddle, B, which in its turn is bolted, screwed, or rivetted to the boiler. The cap, C, which fits accurately, yet easily, upon the piston, A^1, is at the same time the valve, whose seating is at I. The bore of the tube, A^3, is enlarged towards the upper end of the piston, A^1, to admit of the conical tongue, C^1, the object of which is to prevent binding of the cap, C, from the side pressure of the pivot, D, upon which the lever, E, rests; and the tube, G, is screwed to the socket of the pipe, A^3, and made to reach down into the boiler below the water level. The weight suspended from the end of the lever, E, corresponds with the desired normal pressure in the boiler, and as soon as the steam pressure increases, the water which is forced up to and penetrates the space between the piston, A_1, and the cap, C, gradually raises the cap from its seating, until the open space between the valve and its seating is equal to the effective area of the spaces between the feathers, A^1, when the further rise of the lever, E, is arrested by the pin, H, in the top of the standard, I. Whilst the cap, C, is thus raised, the steam will escape in the direction of the arrows until the pressure in the boiler is once more reduced to its normal state; whereupon the weight will, through the lever, E, force the cap, C, down upon its seating, and close the valve.

"When the valve is to be actuated by steam, instead of by water, the pipe, G, is bent and conducted to a part of the boiler where the blowing off of the steam will not exert any perceptible influence upon that body of steam which is intended to raise the cap, C. It will however be preferable, when steam is to be employed for raising the cap, and especially where the water is bad, to use a valve, as shown in vertical section in Fig. 3. In this case the tube A^3, instead of being carried straight down into the boiler, as shown in Fig. I, communicates with the pipe, G, through the passage, A^4, and socket, G^1, which latter is screwed to the plate A. The pipe, G, enters into the steam space of the boiler at as great a distance from the valve as practicable; and from the condensation of the steam between the bend of the pipe, G, at * and the valve, a body of dis-

BODMER'S IMPROVED SAFETY-VALVE.

FIG. 2.

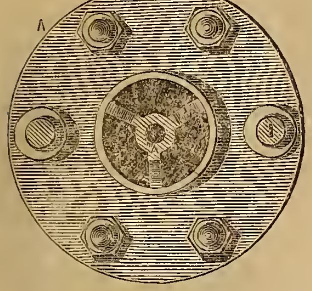


FIG. 3.

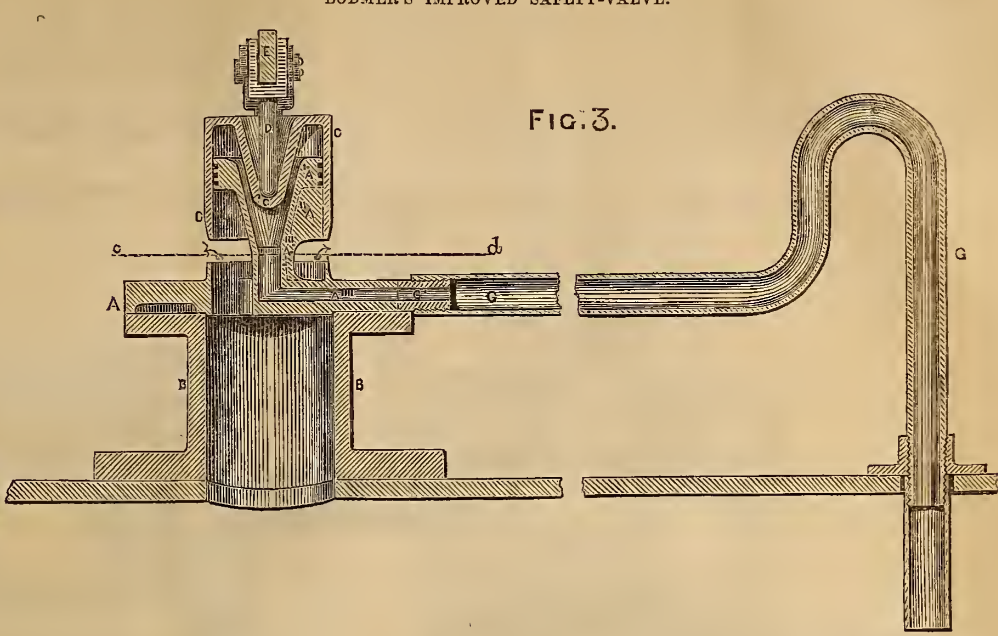
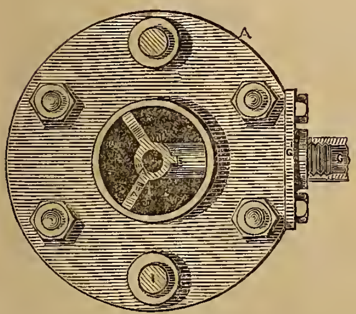


FIG. 4.



tilled water will accumulate, upon which the steam will act with undiminished pressure, and which will effectually prevent the formation of any sediment which might impair the free action of the valve.

"Square grooves are cut round the top of the piston, A[1], for the purpose of retaining a portion of water, which, whilst reducing friction, is found to form an excellent steam and water-tight packing, and obviates the necessity of making the cap, C, too tight a fit upon the piston, A[1].

"It is scarcely necessary to observe that, instead of the weight, a spring balance may be employed, or weights or springs may be applied to act directly upon the valve.

"By way of comparison between this valve and those of the ordinary construction, it may be mentioned that a 4-in. patent valve is equal in efficiency to a common valve of 64 in. diameter."

MEDALS FOR THE ARMY IN INDIA.

WE have learnt from excellent authority that medals are to be struck at the Mint, forthwith, for the troops who have been engaged in the suppression of the terrible rebellion in India. One hundred thousand are to be distributed in the first instance, and it is lamentable to think how many of them can only be claimed by the *representatives* of men engaged in the sanguinary work. Hundreds of fine fellows, from Havelock downwards, have alas! fallen victims to duty on the plains of Hindostan; and it is a melancholy solace to their sorrowing relatives, that the country they so worthily fought for is not unmindful of their services. These decorations will serve as *souvenirs* of the departed, and rewards for the living, heroes of the British Indian Army.

Of the medal itself we may say that, judging from the character of the dies, which we have seen, it will be worthy the artistic skill of the Nation. Its size will be precisely that of the Crimean, and it will be composed of the same metal—fine silver. The obverse represents the well-known features of Her Most Gracious Majesty, engraved in fine relief, and with a minuteness of detail which is in the highest degree indicative of the talent of the engraver. The tiara which decorates the head of the Queen, is of marvellously elaborate workmanship. Wyon, the elder, is the author of this fine portion of the work —the obverse die, that is. The reverse consists of a noble and erect figure of Britannia, whose countenance beams forth admiration, and who, extending her right hand, in which is a wreath of laurel, appears as if in the act of rewarding a victor. In her left hand are other wreaths, destined, apparently, to be successively bestowed upon those who have earned them. Beside Britannia stands a lion—significant of indomitable courage and giant strength, and above her head is placed the single word "INDIA." Mr. Leonard Wyon is the engraver of the reverse die, which bears the dates 1856-1859. The only inscription on the obverse is the words "VICTORIA REGINA." It is intended to give clasps for each of the principal engagements throughout the war, in addition to medals; and certainly never were military rewards more fairly won than are these same medals and clasps. The Indian Army and its noble leaders have established the character of the English soldier on a basis so enduring, that it will last for "all time," and it is but meet that the British nation acknowledge and substantially recognise the fact.

ON M. BEAUFUMÉ'S SYSTEM OF HEATING STEAM-BOILER AND OTHER FURNACES BY MEANS OF GAS PRODUCED BY A PARTIAL CONVERSION OF THE COAL.

Compiled from Documents communicated by the COUNT DE LA TAILLE DES ESSARTS.

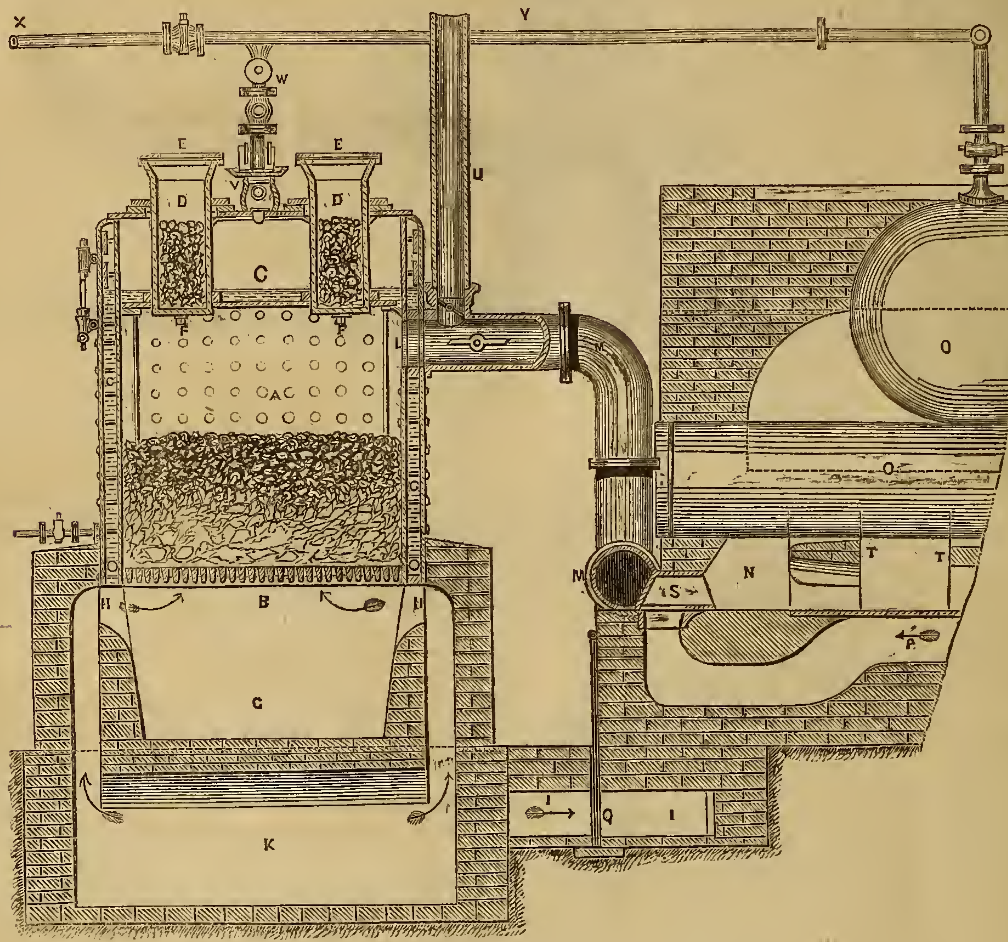
By DR. RANKINE, and read before the Institution of Engineers in Scotland.

(Illustrated by Woodcuts.)

INSTEAD of burning coals in the furnaces of steam-boilers in the ordinary way, M. Beaufumé first converts them into gas, and then burns this gas beneath the boilers. The ordinary coal gas or carburetted hydrogen, produced by distillation in closed retorts, though well adapted for lighting purposes, is too costly where great heating power is required. The gas produced by M. Beaufumé is a mixture of carbonic oxide and carburetted hydrogen, and possesses great heating, but small lighting power. He obtains the gas by partially burning and wholly distilling the coal in a furnace or gasifier, into which the proper quantity of air is forced. This air passes through an incandescent layer of the coals, and its oxygen combines with the carbon to form carbonic acid gas, which, passing upwards through less heated layers of coal, assumes a second equivalent of carbon, and becomes converted into carbonic oxide. It is a mixture of this carbonic oxide with the distilled hydrocarbons of the coal which is conveyed to and burned in the furnace of the steam-boiler, after being mixed with the quantity of atmospheric air necessary for complete combustion, which takes place without the production of smoke.

The inflammable gas is produced in what M. Beaufumé calls a gasifier. This apparatus is represented in longitudinal and transverse vertical section in Figs. 1 and 2, Woodcut, and consists of a furnace, A, very like a locomotive fire-box in shape, and surrounded on all sides, except beneath the grate-bars, B, by a water space, C, which prevents loss of heat by radiation, and in fact constitutes a small detached boiler raising a certain amount of steam to be added to that of the main boiler. The furnace is filled with fuel to a considerable height, say 20 to 28 in., according to the quality of the coal. The coal is introduced by two double-valved passages, D, in the roof of the furnace. When the outer cover, E, of either passage is opened, the valve, F, at the inner end is

closed to prevent the escape of gas. When the fuel is introduced into the passage, the outer valve, E, is closed, and the inner one, F, opened, and the fuel falls into the furnace, no more gas escaping from the furnace than the small quantity filling the passage, D. Instead of leaving the supply of air to the uncertain action of a draught, the proper quantity is forced between the fire-bars by a blowing-fan. The air enters the ashpit, G, by apertures, H, on opposite sides, whereby a uniform pressure is obtained without partial currents. When the apparatus is properly regulated, the top layers of coal remain in a black and comparatively cold condition, the layers near the fire-bars alone becoming incandescent. Carbonic acid gas is produced amongst the incandescent layers of fuel; but this gas, passing up through the comparatively cold layers, combines with additional carbon to form carbonic oxide. This carbonic oxide, mixed with whatever gases are formed from the bituminous constituents of the coal, passes off by an outlet, L, near the top of the furnace, and is conveyed by the pipe, M, to the furnace, N, of the steam-boiler, O. Certain simple but peculiar arrangements are necessary in the boiler furnace for the efficient combustion of the gases. The air to be mixed



Beaufumé's Furnace.—Fig. 1.

with the gases is supplied by means of the same blowing-fan which supplies air to the gasifier, and is made to traverse a circuitous passage, P, exposed to the waste radiant heat of the furnace, so as to become heated. The inflammable gases issue from the supply pipe, M, by a series of passages, R, arranged in a horizontal line, at short intervals apart, whilst the air issues by passages, S, occupying the intervals between the gas passages, R. In Fig. 1 the section is taken through one of the air passages, whilst in Fig. 2 the pipe, M, is sectioned in such a way as to show the gas passages. With this arrangement the air and gases become well mixed, and are burnt in a uniform and complete manner. Several fire-brick arches or deflectors, T, are arranged in the furnace to insure the complete inflammation of the gases, by receiving a portion of the heat of the flames already formed, and communicating it to the as yet uninflamed gases. These deflectors also serve to a certain extent to protect the boiler surface from the too intense action of the flames. The gases remaining after combustion pass through the flues, and escape into the atmosphere, under the pressure due to the blowing-fan, no chimney being required.

Amongst details not specially referred to in the preceding description, are—

The air-ducts, I, J, the former of which conveys air to the steam boiler furnace, whilst the latter admits the supply for the gasifier into a passage, K, beneath the ashpit, G, and communicating with the apertures, H, at each end. A portion of the air-duct, I, is seen in Fig. 1, where a damper, Q, is applied for the purpose of regulating the supply. From this point the passage is carried along to the back-end of the boiler, near the bottom surface of the furnace, and is shown returning at P, Fig. 1; this circuitous route being adopted to heat the air by the heat that would otherwise be wasted. A pipe, U, is provided for the discharge of the products of combustion on the fuel in the gasifier being first lighted. The gasifier boiler is provided with safety-valves, V, and the steam from it passes off by the pipe, W, from which a branch, X, conveys a supply to the small donkey-engine driving the air-fan, whilst another branch, Y, communicates with the main boiler, O. It is found advantageous to inject steam occasionally below the furnace-bars, B, of the gasifier furnace, and this is done by means of the pipe, Z, Valved openings, *a*, are formed in the side of the gasifier for the purpose of examining and stirring the fuel, and doors, *b*, are provided for cleaning the furnace-bars and ashpits.

An apparatus constructed on M. Beaufumé's system was last year tried by the French Government, at the Imperial Arsenal at Cherbourg,* and the Table and Notes annexed are abstracted from a report of the experiments then made, by MM. Guesnet, Admiralty Engineer, and Sochet, Director of Naval Construction. Four series of experiments were made, the results of which are given in the Table. The first three series of experiments were made with the boiler of the establishment, called the Northern Forge at Cherbourg. This boiler was of 12 H.P.,

* Permission has been obtained to erect M. Beaufumé's apparatus at Woolwich Dockyard, for the purpose of testing its capabilities.

it had a total heating surface of 167½ sq. ft., and its ordinary grate surface was 12¼ sq. ft. The gasifier supplied by M. Beaufumé had a grate surface of 5¼ sq. ft., and a depth of fuel of 27½ in. could be consumed in it. The apparatus was 11½ ft. high, and occupied a space of 10 ft. by 6½ ft. The air-supplying fan was driven by a donkey-engine at the rate of 1,000 revolutions per minute, and the blast produced was equal to a column of water 1·97 in. high.

The fourth series of experiments were made with one of four tubular boilers lying in the boiler-yard at Cherbourg, ready for the steamer *Antelope*.

RESULTS OF EXPERIMENTS MADE AT CHERBOURG WITH M. BEAUFUMÉ'S HEATING APPARATUS.

Date.	Duration of Experiment.	Total amount of Fuel Consumed.	Kind of Fuel.	Water Evaporated. During the Expmt.	Water Evaporated. Per Hour.	Water Evaporated. Per lb. of Coal	Observations.
Series No. 1. The Boiler of the Forge heated by the ordinary Furnace.							
May	H. M.	lbs.		lbs.	lbs.	lbs.	
7	8 30	970½	Large Newcastle Coal.	4620	543·5	4·865	
8	8 31	1014½		4905	561·9	4·835	
Series No. 2. The Boiler of the Forge heated by the Beaufumé Apparatus.							
May							
28	8 45	908½	Large Newcastle Coal.	5640	644·4	6·21	
29	8 30	1958½		7110	836·5	6·71	
30	8 30	1921		6621	778·5	8·26	
Series No. 3. The Boiler of the Forge heated by the Beaufumé Apparatus.							
June							
2	8 30	847	Small Coal	6131	875·6	7·24	
4	8 30	811½	Cardiff	6744	791·8	8·30	
6	8 0	761	Newall's Llanelly.	5518	689·7	7·25	
Series No. 4. A Tubular Boiler heated by the Beaufumé Apparatus.							
June							
12	7 0	1500	Newcastle Coal.	12751	1821·6	9·035	Weather cold.
15	5 15	849		7353	1400·4	8·066	
16	7 15	1235		12218	1676·2	9·820	
17	7 0	1235		11618	1659·7	9·407	
18	6 0	1058½		9788	1631·3	9·245	
23	5 0	1058½		9420	1884·0	8·897	Weather temperate.
25	9 0	2029		17719	1969·5	9·038	
26	2 30	476½		6921	1885·7	9·898	36 out of 106 tubes closed.
29	3 45	653		6923	1846·0	10·600	42 out of 106 tubes closed.

MM. Guesnet and Soehet conclude their report in the following words :—

"From what has been said it is obvious that M. Beaufumé's heating apparatus works with perfect regularity, is quite free from smoke, and effects a great saving. The saving derived from it, as compared with the ordinary system of heating, reached as much as 38 per cent. in our experiments, and there is no doubt that the saving of one-third may be reckoned upon with certainty.

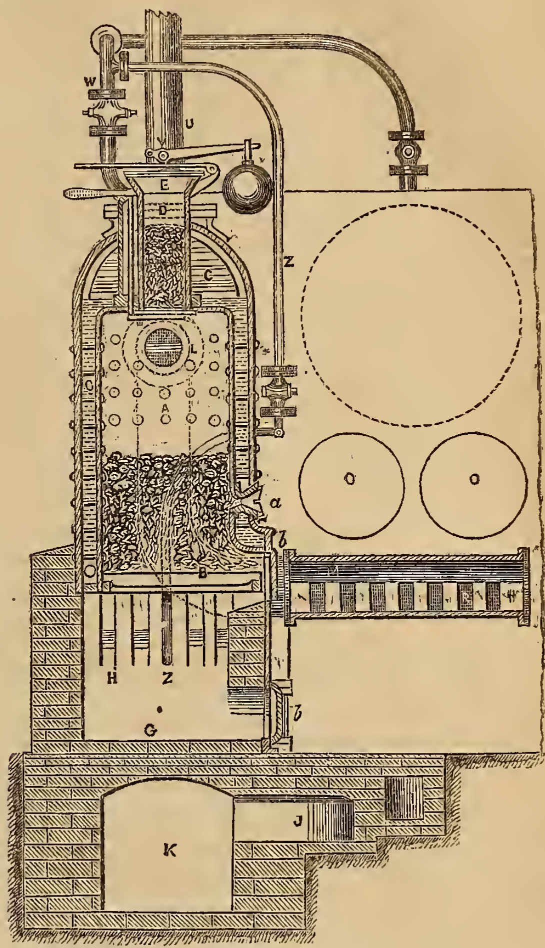
"There are no difficulties in working the apparatus: it requires, perhaps, a little extra care and attention, but not so much as to constitute a matter for serious consideration.

"It has the advantage, above all, of being able to use economically fuel of a kind which can only be burnt in ordinary furnaces with great difficulty, such as small coal.

"It has the inconvenience of throwing a quantity of carbonic oxide into the boiler-house; and although this is not of much importance on land, it might be serious on board ship. This defect is less, the less frequently the fuel is stirred up; and with Cardiff coals it scarcely exists, as they do not require stirring up. We must also remark, that although M. Beaufumé's apparatus has reached a practicable state, it is still too recent an invention to be incapable of improvement, and M. Beaufumé hopes, and we believe it quite possible, to remove the defect in question altogether.

"With this apparatus the getting up of steam at starting requires no more time than with ordinary furnaces, when the boiler works every day; but it is otherwise when the apparatus is cooled down, and no motive force is at hand to drive the blowing-fan, before the gasifier is itself capable of driving it. An extra half hour is, under these circumstances, always required to get up steam in the boiler. This is doubtless a great inconvenience, but it would disappear if a small donkey engine, with a small boiler capable of getting up steam very rapidly, were employed specially to set the apparatus agoing.

"Finally, this apparatus takes up a little more room than is ordinarily required.



Beaufumé's Furnace.—Fig. 2.

"We do not think that the inconveniences we have pointed out can be compared with the advantages of regularity, freedom from smoke, and great saving, which it possesses, more particularly over all land boilers; and we consider this new system of heating so decided an improvement upon other systems, that it will be desirable to make some attempts to introduce it for marine purposes also.

"We must not conclude this report without mentioning that the Beaufumé apparatus may be employed in the arsenal in other ways besides heating steam-boilers. It could probably be used with great advantage in the furnaces of the forge, and it would be desirable to try it for this purpose at Guérigny."

The President gave the following additional particulars :—The experiments at Cherbourg were made under very unfavourable circumstances. The boiler used in the first, second, and third series of experiments was evidently a very bad one, as, with the ordinary furnace, only 4·83 lbs. water were evaporated per lb. of coal. In all the experiments the water supplied to the boiler was cold; and as it is usual to reduce the results of experiments of this kind to the results which would have been obtained if the boiler had been supplied with water of a temperature of 212°, we must add 18 per cent. to the results obtained in the first, second, and third series, and 16 per cent. to those obtained in the fourth series of experiments. With this correction, the results obtained become in one case 9·8 lbs., and in another 10·5 lbs., evaporated per lb. of coal. The proprietors of the apparatus obtained even better results in their own experiments, in which the water supplied was of a temperature of about 100°. One of the best results obtained was equivalent to an evaporation of nearly 12 lbs. of water per lb. of coal from a temperature of 212°.

ON EMPLOYING STEAM EXPANSIVELY.

By Mr. Alexander Morton.

(Continued from page 244.)

There are other means of superheating steam: for instance, if steam be generated in a vessel at a high pressure, and then allowed to expand freely into an empty vessel, that portion which enters first expands, and is immediately afterwards compressed by the following portion. The volume of the steam by this compression becomes superheated, and possessed of an elasticity greater than that due to its density. Watt denied that there was any increase in the total heat in saturated steam. Southern asserted that the whole of the augmentation in temperature was so much additional heat. When steam is generated under an increasing pressure, we find that the pressure rises very slowly at first; but the more the temperature rises, the more rapidly does the pressure increase. From this fact many have thought that less fuel was required to evaporate water at the higher pressures; but Watt, Christian, any many others, found that an equal quantity of fuel was required to evaporate equal quantities of water under different uniform pressures. Experience has shown that rather more fuel is required to evaporate water at the higher pressures, and this is probably because the difference of temperature between the furnace and the boiler is less as the pressure is increased, and the loss by radiation is also increased. With ordinary pressures only about 5 per cent. extra fuel is required. When evaporating water under an increasing pressure, the whole volume of water in the boiler has to be raised to a corresponding temperature, and we know that an increase of about 40° Fahr. is required in raising the pressure from one to two atmospheres, and only 46° Fahr. additional in raising it from two to four atmospheres. If the steam space is small, and if there is a great body of water in the boiler, the fuel required to raise the pressure from 15 lbs. per inch to 30 lbs. per inch may be nearly double that required to raise the pressure an additional atmosphere—namely, from 30 to 45 lbs. per inch. This is the cause of the greater velocity as the pressure increases. Some very successful trials of mixing saturated steam with superheated steam have been made lately, and many would at first wonder when told that two different steams of the same pressure, when mixed together, suddenly became of a higher pressure. In several experiments which I have performed with steams of little above atmospheric pressure, with their respective temperatures about 500° Fahr. and 214° Fahr., the pressure instantaneously increased. I intend in future experiments, if possible, to define the amount. Having already said that the latent heat made sensible by condensing a certain weight of steam depends upon the speed of condensation, I may add that I am of opinion that saturated steam, when mixed with water at about 60° Fahr., is condensed at the same speed as that at which it was generated, because the same quantity of fuel which generated the steam can, if applied directly to the water, raise the same volume through nearly an equal number of degrees; but apart from this, if high-pressure steam be condensed without being allowed to expand (which is easily accomplished by filling the condenser with air at nearly the same pressure), the heat made sensible is less than that of low-pressure steam, if measured in the same manner. The greater weight of the air slightly prevents the speed of condensation. Steam can be viewed as a body in motion. If its motion is destroyed in a given period of time, the amount of heat made sensible is equivalent to that required to give an equal body the same amount of motion in the same time. In expanding steam under a steam-engine piston, a very small portion would resume the form of water if 1,000° Fahr. were liberated to supply the then remaining steam, as generally believed; but as the steam very slowly resumes the form of water in expanding, a great quantity would consequently require to condense to supply the demand, and in a steam-engine where no means of supplying the expanded steam is adopted, if cutting off at, say, half-stroke, with an ordinary motion, no water in the cylinder may be perceptible; yet, if the steam be cut off at one-fourth of the stroke, the piston running at the same speed, the greater quantity of water in the cylinder will distinctly tell upon the fuel consumed.

Steam, viewed as a body in motion, cannot be expected to impart motion to another body, without an equivalent diminution in its own motion; yet, in considering the action of steam in an engine working with a uniform pressure throughout the stroke, many entertain the idea that the steam is nothing impaired when the stroke is accomplished, because they find a cylinder full of steam at the same temperature and pressure as at the beginning of the stroke; and a cylinder full of steam is thrown into the condenser. This is no doubt the weight of steam thrown into the condenser; still it forms no measure of the quantity of steam which left the boiler. On motion being given to the piston, a certain portion of the steam loses its motion, and becomes water of the surrounding temperature. Additional steam from the boiler occupies the place of the previous steam, and this change of motion continues as long as the piston continues to receive motion. Undoubtedly a very small percentage of the motion in steam is utilized in this manner, compared with the quantity thrown into the condenser; but by increasing the load on the piston it is easy to see that a greater percentage will be utilized, and that greater economy of fuel will follow. Oliver Evans, and many others, have distinctly mentioned that it did not require double the fuel to double the work of an engine working full pressure. There are many aware that steam assumes the form of water in expanding under pressure, who still believe that the portion condensing gives out 1000° Fahr. (which is termed the latent heat) to superheat the steam still remaining. If, however, the motion in steam could be absorbed by producing motion in another body, and still 1000° Fahr. made sensible, we could then gain motion or heat without fuel; but when we consider that the motion in steam is wholly absorbed by another body, we cannot expect even 1° Fahr. to make itself sensible in expanding the remaining steam. On again referring to the indicator figures, we find that when the steam is suddenly expanded, it rapidly diminishes in both temperature and pressure, and being below the temperature of the cylinder and piston, it abstracts the heat from the cylinder and enlarges the whole volume, which again diminishes by the rapid expansion. This change of motion, or condition, abstracts an equivalent amount of heat from the cylinder, which must be supplied from the entering steam, with a proportionally increased expenditure of fuel; consequently, the greater the degree or speed of expansion, the slower should the velocity of the piston become, unless the motion in the steam is preserved by heat from another source. The motion in steam, or any other body, can be preserved with a less expenditure than that required for its production; and in steam engines where this has been attended to, great economy has been obtained. I do not mean that steam should be superheated above what is necessary to preserve its motion, for, if the steam be superheated, the whole is thrown away at the termination of the stroke, unless means are employed for recovering the heat. A certain portion of this heat is recovered in the Cornish engines, as I have already noticed, by closing the equilibrium valve before the end of the stroke; and as the moving mass is increased, the greater volume of this superheated steam is retained and compressed. It is proverbially well known throughout Cornwall that the duty of the engines has increased as the mines have been wrought deeper, and the moving mass consequently increased; and many have also found a gain by increasing the moving mass in crank engines. I have already briefly explained the cause of this increased duty, when considering the action of an engine working with a uniform pressure throughout the stroke. When the load is increased in the Cornish engines, the degree of expansion is also increased, the velocity of the piston diminishes, and a greater portion of the superheat is recovered from the previous-stroke steam, by retaining a greater portion in the clearance space in the manner already explained. These advantages outweigh the loss by the extra friction of the greater moving mass. I have, by repeated experiments, found that, as asserted by high authorities, the consumption of fuel required to raise a given volume of water through a given number of degrees is equal, whatever is the time in which it is accomplished. By the consumption of 1 lb. of fuel, a certain volume of water is raised in temperature 10° Fahr. in an hour; and the consumption of 2 lbs. of fuel can raise the same volume of water twice as rapidly, that is, 20° Fahr. in an hour. Here is, therefore, a means of gaining or losing time *ad libitum*, if the rise in temperature is the work required from the fuel. It follows, as a consequence, that if we construct a furnace to consume 4 lbs. of fuel per hour, instead of 2 lbs., we can then raise double the quantity of water through a given number of degrees in a given period of time, which will undoubtedly be a great gain. When saturated steam is mixed with water at about 40° Fahr., 1040° Fahr. become sensible; but by another experiment, to which I have already alluded, 680° Fahr. become sensible. Here then is a means of losing heat, because the steam was condensed in a longer period of time. If the motion of a body be absorbed by another body of equal weight in an almost inconceivably short period of time, an equal amount of motion is produced in the latter body; but if the first body impart its motion during a greater length of time, a correspondingly longer period of time is required to produce the same motion in the second body.

From these considerations it would appear that time, heat, and motion, can be lost; but I have already alluded to the intimate connection between the three, and no one of them can be lost without producing an equivalent of one or both of the other two. We have been led to believe, upon high authority, that there is no more possibilty of increasing the power of an engine by merely altering its working parts, than there is of increasing the effect of a waterfall by arranging the pipes which serve it. Fortunately, those who have found it necessary to apply a constant stream of cold water upon the crank-pin and other bearings of short-stroked engines cannot believe in such an absurdity, knowing that heat cannot be made sensible without destroying motion. Witness the effects of experimental engines constructed with the view of economising fuel, by carrying the expansion of saturated steam very far. Experience has taught us that our previous theory of expansion was at fault; and without fear of contradiction, I assert that the engines in Cornwall have, for the last twenty years, given more economical results when cutting off at about half stroke, than the generality of our high-pressed double-cylinder expansive engines (excepting cases where an additional amount of heat

is supplied to the steam, corresponding to the speed of its expansion). I shall now endeavour to explain the action of the steam in the cylinder of the experimental engine, when the velocity of the piston was increased, Fig. 3 being traced by the pencil of the indicator. I may first mention that almost precisely the same figure was traced whether the paper's surface was rough or smooth, or the pencil spring of the indicator strong or weak. When the steam first enters the cylinder, the piston is

Fig 3.

at that instant in a state of rest or equilibrium; the action of the steam upon the piston causes it to recede very slowly at first, and a certain portion of the steam's motion is destroyed, having been absorbed by the piston. But as the steam valve is still open, fresh steam is supplied from the boiler, and as the piston's motion is accelerated, a greater portion of the motion in the steam is absorbed; and as soon as the steam supplied is deficient, either from the passage being too contracted, or from being wholly intercepted by the closing of the cut-off or steam valve, the pressure immediately diminishes, as shown by the first fall in Fig. 3. At this point the steam has so suddenly imparted its motion to the piston, that its temperature is reduced below that of the cylinder in which it is contained; but although it is at a low temperature, it has not resumed the form of water, but is what I shall term supersaturated steam, being possessed of a density greater than that due to its pressure. This supersaturated steam being of a lower temperature than the cylinder and piston, absorbs heat from the cylinder,—this heat endeavouring to restore equilibrium by supplying the demand, and the motion or pressure of the steam again increases, as shown by the rise of the second oscillation. The piston being still in motion, again absorbs the motion of the steam with greater rapidity than that with which the cylinder can supply the requisite heat; and the steam, consequently, falls in temperature. This change of motion would continue as long as the piston continued to move, the cylinder still endeavouring to supply the heat required by the expanding steam. It will be distinctly noticed, on examining the figure, that as the velocity of the piston diminishes towards the termination of its stroke, the time of an oscillation increases, and the variations diminish, as already explained when considering the same phenomenon in a jet of high pressure steam issuing freely into the atmosphere. If a certain weight of cast iron, at the highest temperature of the cylinder, is immersed in cold water, a very small quantity of heat is made sensible; and on noticing the indicator figure at the period when the first abstraction of heat from the cylinder takes place, we find that the whole volume of the steam in the cylinder has been raised in pressure by the heat it has received from the cylinder and piston in a very short period of time. I must remind you that steam supersaturated by expansion, requires very little heat to recover its motion, compared with that required for its production. On comparing Figs. 2 and 3, or on measuring the curve of compression, we find that the pressure increases in a much greater ratio at the higher velocities.

We have generally understood that any body falling freely by the action of gravity, and having its motion destroyed by a perfectly elastic material, would rebound and ascend to precisely the same height as that from which it fell, in an equal period of time; if, therefore, a body descends in one second of time, by the end of the next second we expect to find the ascending body at precisely the same height, and equilibrium again restored—quite independently of the time occupied in the change of motion. If we can conceive the change of motion to have been accomplished in no time, then this law would be correct; but as we know this to be impossible, we may rest assured that whatever time is occupied in destroying motion, the same time is required to reproduce it in the same body. When a body is projected upwards with the velocity of 32 ft. per second, its motion is destroyed in one second of time by the action of gravity, and we find that exactly one second of time is required before it returns with the same velocity. This is, undoubtedly, a universal law, and shows that time can be lost. I have now to mention an equally important law—namely, that the heat made sensible by destroying motion or restoring equilibrium in any moving body, depends wholly upon the time in which the motion is destroyed. If the heat made sensible by destroying the motion of any body in a unit of time can be wholly utilized in again restoring an equal motion, this will undoubtedly be accomplished in a nearly equal period of time; but if two units of time have elapsed in destroying the motion, then the heat made sensible cannot possibly restore a similar motion in less than two units of time. I have repeatedly proved this by experiments, and I find steam forms no exception, being merely water in motion. Those who have performed experiments with the view of discovering the amount of latent heat in steam, arrived at different results, the cause of which I shall, with your permission, endeavour to explain in a future paper, along with drawing and description of the apparatus I employed.

In conclusion, I would remark that the key to the various phenomena I have been discussing, as well as to many others, lies in the fact that gravitation endeavours to restore equilibrium or rest in all bodies. Motion follows on equilibrium being destroyed, and ceases on its being restored. Thus in the case of the jet of steam (Fig. 1) issuing freely into the atmosphere, at first a certain portion of the air is robbed of its heat to supply the suddenly expanding steam; and then an equal portion of air is heated, and equilibrium again restored.

The President said, he had requested the secretary to put on the board some extracts from a table of results obtained by Regnault, which seemed to bear upon the part of Mr. Moreton's Paper in which he treated of the heat made sensible on condensing steam. A translation of the Paper from which these figures were taken was in a volume of the Cavendish Society's publications. With reference to the cold felt in a jet of steam issuing into the atmosphere, he might mention that Messrs. Joule and Thomson had made some experiments with compressed air allowed to rush out freely into the atmosphere. They found that the temperature fell in the rapid part of the current, but the heat was almost all reproduced when the motion had quite subsided. Mr. Joule had also tried some more recent experiments on steam, which had not as yet, he believed, been published. He might, however, mention that nearly similar results had been found in experimenting with steam; the heat, however, not being so completely reproduced as in the case of air. As regarded the latent heat of steam, Mr. Moreton differed from other experimenters. In one case he had found 1040° given out, and in another only 680°. These results did not agree with those obtained by Regnault, and noted on the board. Regnault's experiments were most elaborate, and conducted with every possible care, at the expense of the French Government. The entire table for the boiling point of 212° Fahr. gave the result of 44 different experiments, and the greatest difference in the latent heat obtained was not above 1-300th part. The six experiments noted on the board were made by Regnault, to test whether a difference in the rapidity of condensation made any difference in the result. Thus in one experiment the time occupied was three times as long as in another, in which about one-fourth more steam was condensed, and yet the difference in the results was exceedingly small. In another set of 73 experiments, Regnault found that the total heat of steam of different pressures was about 3-10ths of a unit of heat more for every degree of increase of the boiling point, corresponding to the pressure. Thus steam of a pressure corresponding to 222° would give out 3 units of heat more in *condensing*, and *cooling* to a fixed temperature, than steam of atmospheric pressure corresponding to the boiling point of 212°. With regard to the oscillations shown in the diagram, Fig. 3, he might observe that their cause had been much questioned. Some had thought the oscillations entirely due to the action of the indicator spring, but this could not be considered to have been proved, and there were good grounds for attributing them to the varying condition of the steam. Questions of some importance were brought forward in the Paper as to whether cushioning was a source of economy, and as to whether loss of heat was caused by allowing the steam to escape too suddenly from the cylinder.

ON EMPLOYING STEAM EXPANSIVELY.

By Mr. Alexander Morton.

[Second Paper.]

(Illustrated by Woodcuts.)

Referring to my first Paper on this subject, I shall now endeavour to explain the apparatus employed when experimenting on the latent heat contained in steam. In the diagram Fig. 5, Woodcut, the apparatus is represented in section as employed when the steam was condensed by being mixed with cold water in the calorimeter. The boiler, A, is made of very thin copper, and is covered with felt to prevent radiation. The calorimeter, B, is made of tin plate. At C is the steam-pipe for conveying the steam from the boiler to the calorimeter. A thermometer, D, indicates the temperature of the steam in the boiler, whilst a thermometer, E, indicates the temperature in the calorimeter. A small cock, F, is used for adjusting the weight of water in the calorimeter when placed in the balance. In performing the experiments, the boiler, A, was correctly weighed, when empty, in a spring balance; and then a suffi-

cient quantity of water was introduced, and the whole was again weighed. The gas flame was, by repeated experiments, so adjusted that two ounces of water were evaporated in ten minutes. I may mention that a gas flame is a very regular fire to experiment with. The calorimeter, B, was then filled with water at about its maximum density, and at a temperature of 40° Fahr., and when placed in the balance the extra quantity of water was allowed to escape by the cock, F, until the exact weight became 10 lbs. The weight of the calorimeter itself, when empty, was always balanced so that 10 lbs. was the exact quantity of water introduced. This was a constant quantity throughout the experiments. I at times varied the temperature of the water, but the experiment I am describing was performed with water at 40° Fahr. Although the temperature of the room was 8° Fahr. above the temperature of the calorimeter, the elapse of ten minutes made no difference on the mercurial thermometer, E, perceptible by the naked eye; but, independently of this, I followed

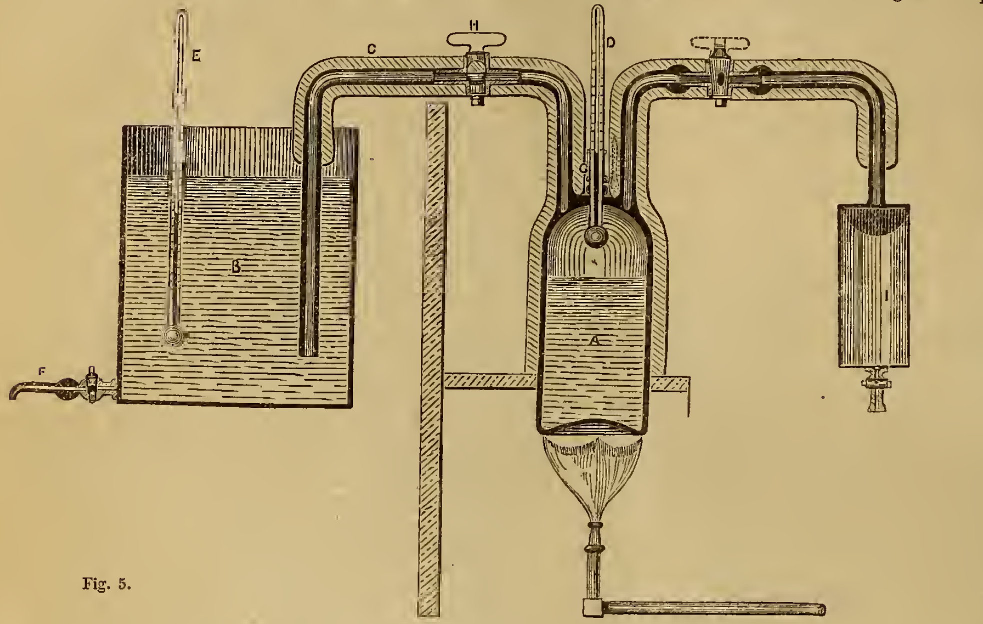


Fig. 5.

Rumford's plan in adjusting the temperature of the calorimeter, so that the opposite differences of temperature between it and the surrounding air at the commencement and conclusion of the experiments were equal; therefore the error on this point was almost nothing. The flame was then applied to the bottom of the boiler, A, and its temperature rose to the boiling point as ascertained by the thermometer, D, the small cock, G, being open to the atmosphere. The quantity of water carried off by the vapour in raising the temperature to the boiling point depends upon the time occupied, if it has free access into the air; but this item was so very small in my experiments that I need not give it a figure. The boiler, A, being now ready, the time was noted correctly, and the communication opened between the boiler and the calorimeter by turning the cock, H. At the expiration of ten minutes the communication was closed, and the gas flame withdrawn. After slightly stirring the water in the calorimeter by moving the thermometer, E, the increased temperature was noted and found to be 55° Fahr. The calorimeter was then weighed to ascertain the exact quantity of water added by the condensation of the steam. The diminished quantity of water in the boiler served as a check upon the additional quantity found in the calorimeter, which, by repeated experiment, was rendered always 2 oz. I may mention that the time occupied in weighing the boiler and calorimeter at the termination of the experiment did not occupy above 30 seconds, the parts being rapidly placed on a spring balance, and the weight, when empty, being a noted quantity. The weight of water in the calorimeter, which was raised 15° Fahr., was exactly 80 times the quantity or weight of steam condensed; therefore the latent heat was readily calculated to be 1,040° Fahr. The next experiment was performed under precisely the same circumstances, with the exception that the boiler was turned half round, and the surface condenser, I, inserted in the calorimeter. At the expiration of ten minutes, the water in the calorimeter rose only 13·5° Fahr., which gives 920° Fahr. as the latent heat. By reducing the temperature of the gas flame, the greatest result I ever obtained with this condenser was 960°. I next diminished the size of my condenser, in other respects adhering to the same adjustment as in the first experiment. I then found that I could diminish the sensible heat in the calorimeter; and with the condenser shown in Fig. 5, and made of very thin tinplate, when the boiler evaporated two ounces of water in ten minutes the latent heat was reduced to 680° Fahr. I may mention that on slightly agitating the water in the calorimeter, during the time of the experiments, I could raise the temperature so that 720° Fahr. became the amount of latent heat made sensible in the calorimeter. That the slight agitation of the water did not produce the extra heat, I proved by attempting to increase the heat by rapid motion; but although I continued stirring and agitating the water until I was tired, I did not discover 1-8th of a degree extra heat in the 10 lbs. of water. Now, by merely moving the thermometer occasionally during the time of an experiment, the latent heat became increased. The cause of this increased heat in the calorimeter I now explain as arising from the extra speed of condensation, from the hotter water in contact with the surface being displaced by the slight agitation, so that the surface of the condenser was maintained at a lower temperature. I don't mean to say that 1040° Fahr. is the greatest possible amount of latent heat made sensible by rapid condensation; but having made hundreds of experiments, I assert that this number is a very near approximation when the steam is at about atmospheric pressure, and the condensing water with which the steam is mixed at about 40° Fahr. Having discovered that the heat made sensible in other bodies depended wholly upon the time in which the motion was destroyed, I conceived that steam would follow the same law, and it was with the view of ascertaining this that I experimented, rather than to define the quantity, as the best experiments ever performed with this subtle agent can only give an approximation; but I have now no hesitation in saying that steam is merely water in rapid motion.

The most elaborate experiments on the latent heat ever performed have been at the expense of the French Government; and until the recent experiments by Regnault, the sum of the sensible and latent heat was supposed constant at all pressures. Agreeing with Watt, Arago, Dulong, and many others, and knowing of their experiments and the manner in which Regnault's experiments were generally received, I hesitated, and repeated my experiments before venturing to write anything on the subject. In all Regnault's experiments of which I have read, I find, from drawings of the apparatus he employed, that he adopted a large surface condenser, and that the speed of condensation was nearly the same in all his experiments, except that the higher the temperature of the steam when admitted into the condenser, the greater the speed of condensation, and consequently the greater was the heat made sensible in the calorimeter from the same weight of steam. On examining the experiments which he has tabulated we find, in the column indicating the weight of water condensed, sometimes a double *quantity*, and one would at first imagine that the steam must have been condensed at a proportionate speed. But, suppose one particle of steam enters the condenser, the difference of temperature will, in a very short period of time, cause it to resume the form of water; whilst if *two* particles of steam had entered the condenser instead of one, it would be quite possible for them to be condensed with exactly the same *speed*, quite independently of each other, provided the condenser was sufficiently large, as it appears to have been in Regnault's experiments, when the weight of steam condensed in the time is considered. An increase in the difference of temperature between the condenser and the entering steam, is the only means of increasing the speed of condensation with the same apparatus. I believe, steam can be condensed with the same *speed*, independently of quantity; and, as a consequence, the generation of steam must follow the same law; hence, if the difference of temperature between the furnace and the boiler remains the same, any *quantity* may be generated in a certain time, the speed of generation remaining constant. Regnault found that as the temperature and pressure of steam was augmented, the greater was the amount of heat made sensible. From this it is concluded that high-pressure steam contains the greatest amount of total heat. The heat made sensible, I find, depends upon the conditions of the experiment, and when high-pressure steam is condensed without being allowed to expand (as mentioned in my first paper), the heat then made sensible in the calorimeter is not any greater than that of low pressure steam when treated in the same manner. I also mentioned that when high pressure steam expanded from one vessel into another, it suddenly became superheated steam. Now, unless Regnault had followed

a similar course (that is, unless he prevented the steam from expanding in the act of condensing), a greater amount of heat would undoubtedly become sensible in the calorimeter. I have experimented on the latent heat contained in steam for some years, and like many others, could not satisfactorily account for the different results obtained, varying from 940° Fahr. to 1070° Fahr., with exactly the same weight of steam condensed; but, on considering steam to act like other bodies in motion, I followed a different track.

It is easy throughout numerous experiments to generate exactly the same weight of steam in the same time, and it has caused much astonishment that the total heat should vary so much in different experiments. In fact, of all the experiments made public, no two agree; but what I have already mentioned indicates in what direction we may look for a solution of the difficulty. It is now my opinion that, although Regnault paid every attention in his experiments, he was unaware of the influence of time in them.

We are all aware of the heat made sensible at the crank pin and other bearings of short-stroked engines when running at a high speed. This may, to a certain extent, be modified by cushioning a certain portion of steam at the termination of each single stroke, in proportion to the weight of the moving parts, and the time in which the reciprocating motion is destroyed. Short-stroked engines should run with a less mean velocity of piston, because the motion is more quickly produced and destroyed. Three or more times the strain of the greatest steam pressure may be exerted on the crank pin, if the weight of the moving mass is too suddenly brought to rest, and therefore we need not wonder at the heat made sensible at the crank pin. If, for example, a pendulous cylinder engine is so proportioned that its cylinder is suspended at exactly the same distance from the centre of oscillation as a second's pendulum, and if this engine be driven at double the velocity of a second's pendulum—viz., 60 single strokes per minute, then a greater power will be absorbed in giving it motion, and there will, consequently, be a greater motion to be destroyed at the termination of each oscillation, and a certain heat will be made sensible in the bearings. In the numerous instances in which power is misapplied in a similar manner, the same cause will satisfactorily account for the heat made sensible where it ought not to be; and until time is considered, and every steam-engine regulated according to its construction, and to the degree of expansion adopted, economy cannot be the result. Many expansive engines would have proved themselves very economical, had they been driven at the proper speed; but, unfortunately, this has to be settled when the engines are designed, and when on starting the engines, their speed is found deficient, they are then forced at the expense of extra consumption of fuel. If the Cornish pumping engines were forced to run at double their velocity, where would the economy stand? Their speed is diminished accordingly as a greater degree of expansion is adopted, the boiler pressure remaining the same—that is, generally, two or three times the highest pressure required in the cylinder.

I have some remarks to make upon the oscillations produced in steam, when rapidly expanded. Many consider that the oscillatory motion produced in the pencil of the indicator is due to the elasticity of the spring, and to the action of its own momentum. No doubt such effects can arise from the elasticity and momentum of the spring, but why cannot steam exhibit a similar oscillatory motion? Steam is more elastic than any spring, and at high pressures, or, in fact, at any pressure, is not void of weight. Josiah Parkes was the first who studied this phenomenon in steam, and I daresay many still recollect his percussive theory. I have made experiments on indicators loaded with weights, and many similar to Parkes', and I am confident that if the steam in a steam-engine cylinder is expanded at a greater velocity than corresponds to the heat surrounding bodies can supply, oscillations will be produced exactly like those seen, felt, and heard, when a jet of steam issues freely into the atmosphere, as explained in my previous Paper. I have made an indicator, so that it would not oscillate by its momentum, and still the oscillatory figure was produced by the pencil when the velocity of the piston was sufficiently increased.

I have, in these Papers, endeavoured to show that time is required for the generation, expansion, and condensation of steam, and there is no practical difficulty in giving sufficient time to accomplish either with economy. I have before suggested the use of two condensers for each double-acting engine, so arranged that one would receive the greatest volume of the steam before the completion of the stroke, and the other would communicate and act during the return stroke alternately, Still, I see no difficulty, in many instances, in having the steam fully expanded long before the termination of the stroke; a greater time could then be obtained for condensation, by opening the exhaust slowly before the completion of the stroke, the momentum of the moving mass being sufficient to fulfil or complete the stroke. Considering gravity as the result of motion, it follows as a probable hypothesis that bodies descending are acted upon differently from those ascending against that force; however, if this force be destroyed by artificial means, a motion is the result, and any body having this motion against the force of gravity will, in a certain time, have it destroyed, and equilibrium will be restored without producing one fraction of heat; but if the motion be destroyed in a less period of time, then a proportionate amount of heat will appear as the result. Could we supply a force acting against gravity so as to neutralize its effects, any body once in motion would continue so for ever; but so long as any constant force in one direction exists, every body in motion on this earth will, by that all-prevailing force, have its motion destroyed and equilibrium restored. When motion is destroyed by other means, a certain heat becomes sensible, according to the time in which the motion is destroyed. This heat would have constantly increased by every sudden destruction of motion, had we been deprived of an atmosphere; but the heat is absorbed by the air, which, in consequence, ascends, causing an equal quantity to descend and occupy its place. The heat which the ascending quantity of air absorbs is required by that portion which descends: consequently equilibrium is restored by the motion of the air during a certain time. Heat cannot be measured quantitively, as if it were an isolated fluid; but motion must be included, and we can form no measure of motion without including time.

The theory which I now advocate is based upon my experiments; and if I am correct, a low temperature with slow combustion will evaporate a greater quantity of water per pound of fuel than a high temperature; because the higher the temperature of the furnace, the greater is the speed of generation. The motion of a steam-engine piston may be accelerated, during the first part of the stroke, in such a way that the expanding steam cannot follow with sufficient rapidity for its motion to be utilized before the completion of the stroke (see Fig. 3): but if the steam be supplied with heat sufficient for the speed of expansion, it will follow the piston at any velocity, the greater heat increasing the velocity at which the steam can expand. When speed is required, the saturated steam may be supplied with heat whilst expanding, or on its way to the cylinder, by the gases passing from the furnace to the chimney. This would prove economical in engines already constructed, because the portion of heat which the expanding steam requires for its velocity may be said to be wholly converted into power on expansion, as the steam is then found to be minus that additional heat at the termination of the stroke. Steam may be superheated beyond what is due to the velocity of its expansion, and, in that case, the extra heat would be uselessly thrown into the condenser at the termination of the stroke, unless means were employed to recover it. I have already mentioned the way in which a certain portion of this heat is recovered in the Cornish pumping engine; also the increase of pressure which arises when superheated steam is condensed by being mixed with saturated steam. My opinion at present is, that the elasticity of the steam thus suddenly mixed, becomes equal to that of saturated steam of the mean temperature of the two.

Future experiments may determine the advantages to be derived from this system, and I have little doubt that we will arrive at a better mode of recovering the superheat than that adopted in Cornwall. Steam, when suddenly expanded, extracts heat from surrounding bodies; and from the experiments which I have adduced as proof of this phenomenon, it would appear to demand an exact equivalent of heat for the increase of its own motion. I mentioned that, on experimenting with a jet of steam issuing freely into the atmosphere, a mercurial thermometer was the instrument used in determining the degree of heat in the surrounding air, as also in the jet itself; but in other experiments I employed a quantity or mass of wire-gauze (similar to that used in Stirling's refrigerator), which I immersed amongst a known quantity of water, so as to measure the quantity of heat contained in itself after the experiment, and I found less heat as the velocity of expansion increased; the higher pressures abstracting more heat from the wire gauze, instead of increasing its heat, as one would have expected from the description of Ericsson's caloric engine. These facts first led me to consider what heat would be abstracted from a steam-engine cylinder when high pressure steam was suddenly exhausted; and on experimenting with a high pressure engine, the steam being suddenly exhausted at about two atmospheres' pressure, the indicator fell about 3 lbs. per inch; and, lest the spring of the indicator should assist, I clamped the indicator 2 lbs. below the atmospheric line, and at every exhaust it lowered to almost the same point as when free. I tried oil at the grease-cocks, and found a partial vacuum. As the cause of this partial vacuum, I assign the great abstraction of heat from the cylinder by the sudden exhaust. Alban, in his work on the high-pressure engine, attributes this phenomenon to the momentum of the steam, but I think my experiments on the abstraction of heat by sudden expansion show that, in all cases, a slow exhaust will be economical. I am aware that many engines, with their present arrangement of valves, would be crippled in speed, if the exhaust was in any way throttled. But what I advocate is economy, and there are many existing engines wherein the steam could be fully expanded long before the termination of the stroke, the moving parts having sufficient momentum to accomplish the stroke, thereby admitting of a slow opening of the exhaust.

THE EXPANSION OF STEAM IN STEAM ENGINES.

By Mr. J. G. Lawrie.

(Illustrated by Woodcuts.)

By the law of Boyle and Mariotte, the pressure or elasticity of saturated steam is proportional to its density, and the weight being given is inversely proportional to the volume. By this law the pressure of saturated steam of a given weight and double volume is one-half; of a quadruple volume, one-fourth; and so on in the same ratio, under the condition that the expression $\frac{\text{Pressure} \times \text{Volume}}{\text{Weight}}$ is a constant quantity. Upon this law and these facts, engineers have constructed the hypothesis, that when steam expands to twice its volume, the pressure is reduced to one-half; when it expands to four times its volume, the pressure is one-fourth; to ten times its volume the pressure is one-tenth; or, in general terms, that the pressure is inversely proportional to the volume which contains the steam when expanded or compressed. On this principle the diagram, Fig. 4, is constructed, showing that a volume of steam, represented by A B C D, expanded to fill A B E F, is reduced in pressure to one-half; that if it be expanded to fill A B G H, the pressure is one-third; that if it be expanded to fill A B J K, the pressure is one-fourth, and so on, reducing the pressure to one-tenth, when it fills the whole cylinder A B L M, which represents a volume ten times the original volume, A B C D.

On this principle the action of steam in steam-engines has been investigated.

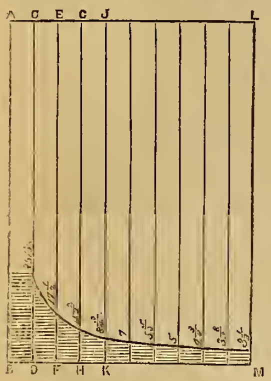


Fig. 4.

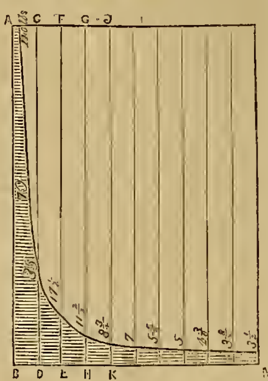


Fig. 5.

Fig. 6.

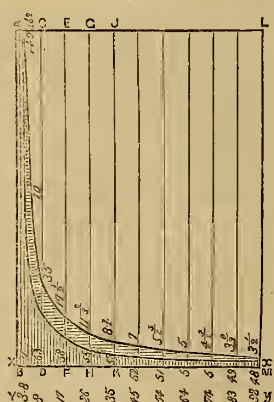


Fig. 7.

Engineers and writers on the steam-engine have assumed it as the foundation of all their calculations, concerning the quantity of steam and water employed in the cylinders and condensers of engines. On an analogous principle, Carnot, the eminent French mathematician, based his dynamical theory of heat, and his exposition of the development of power in the steam-engine and other machines, the action of which depends on heat. On Carnot's principle, steam, in being expanded, loses no heat, and gains none in being compressed.

According to the principle deduced by engineers from the law of Boyle and Mariotte, if the steam originally employed to fill the space A B C D have its initial pressure doubled, and be expanded as before to fill the space A B L M, the power, as indicated by the diagram, will be considerably increased. If the initial pressure be quadrupled, as in diagram, Fig. 5, and expanded as before, the power is further increased; and by every increase in the initial pressure of the steam the power is augmented until, if the pressure be increased to an amount enormously large, say infinitely increased, the power is also enormously large; or if the pressure be infinite, the power derived is also infinite.

On the principle which leads to this conclusion, namely, that the power or mechanical effect which can be derived from a given weight of steam, or, which is almost the same thing, from a given amount of heat, can be increased to be enormously great, by using steam of exceedingly high pressure; all the books written expressly for the steam-engine, without, perhaps, a single exception, or rather with no other exception than a Paper read by Professor Rankine before the Royal Society of Edinburgh, investigate the branch of the subject which relates to the operation of the steam.

The discoveries, however, of recent years—the discovery of James P. Joule, of Manchester, proves this whole system to be completely erroneous. It proves that if heat, by means of steam, imparts power to the piston of a steam-engine, it cannot also remain as heat in the steam, or in the water of which the steam is composed. It proves that for every H.P. imparted to the piston, there is removed from the steam and utilized a quantity of heat which is capable of heating a pound weight of water 423° Fahr.; or when steam is used in the engine of a pressure represented by 20 lbs. per square inch above the atmosphere, for every H.P. imparted to the piston, a quantity of steam, amounting in weight to $\frac{1}{23}$ of a lb., which is somewhat greater than half a cubic foot, is condensed. That with steam of 20 lbs. pressure, for every 10 H.P. given out by the engine, 5·2 cubic ft. are condensed; for every 100 H.P., 52 cubic ft. are condensed; and so on, reckoning $\frac{52}{100}$ of a cubic foot for every H.P., no matter how great or how small that power may be. That this condensation does not arise from radiation, nor from a loss of heat, but from the fact that heat cannot, at the same time, give power to the piston of a steam-engine, and exist as heat either in the steam or in anything else. That no amount of clothing put on the cylinder would prevent this condensation, nor would a steam-case prevent it, although with a steam-case applied, the greater part of the condensation, or generally the whole it, would take place, not in the interior of the cylinder, but in the interior of the steam-case. This law of the exact convertibility of heat and power, or mechanical effect, completely upsets all former calculations of the dynamical action of steam.

By the light of Mr. Joule's discovery, it is obvious that the diagrams in Figs. 4 and 5, do not represent the action of steam in the steam-engine. As the steam issues from the boiler, and impels the piston from A B to C D, it is continually being condensed in the cylinder, and by the time when the piston reaches C D, at which point the steam valve is shut, the space, A B C D, is filled, not with steam alone, but is partly filled with water, the result of the condensation equivalent to the power developed, and the remaining space only is filled with steam. Again, as the piston progresses from C D, onward to L M, the steam is momentarily being condensed, while it is momentarily impelling the piston onward. The condensation takes place, as already stated, at a certain rate for every H.P. developed, but at a rate of bulk of steam which gradually increases as the pressure becomes less. When the piston is travelling from A B to C D, the communication with the boiler being open, the pressure is maintained, although condensation takes place by the influx of new steam; but when the piston travels from C D to L M, no additional steam is admitted, and as the condensation which takes place reduces the pressure, the diagrams, Figs. 4 and 5, do not truly represent the pressure of the steam during the expansion. In Figs. 6 and 7, diagrams are shown representing both the pressures, as in Figs. 4 and 5, and also the reduction which takes place in these pressures due to the condensation of the steam by the development of power. In these Figs. 6 and 7, the spaces shaded with vertical lines show the pressures after condensation, and the spaces shaded with horizontal lines show the amount of condensation. The diagrams are divided into ten parts, and at each point of division along X x, is stated the fraction to which, by condensation, the pressure is reduced below the amount assigned by the mode founded upon the law of Boyle and Mariotte, which is noted along the curve; whilst at each point of division along Y y, is stated the rate of condensation for every 10 H.P. developed. Thus, in Fig. 6, the rate of condensation for every 10 H.P. varies from 5.2 cubic ft. at the beginning of the diagram, to 54 cubic ft. at the end; and in diagram 7 the rate of condensation varies from 3·8 cubic ft. to 92 cubic ft.

(*To be continued.*)

REVIEWS.

A Manual of Applied Mechanics. By William John Macquorn Rankine, LL.D., C.E., F.R.SS.L. & E., &c., President of the Institution of Engineers in Scotland, and Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. Richard Griffin and Co., London and Glasgow. [Third notice.]

(Continued from page 249.)

It is quite evident, from the remarks already made, that we have had no ordinary difficulty to overcome in our attempt to seize the true object for the accomplishment of which Mr. Rankine has written the "Manual of Applied Mechanics."

From its general appearance, and the nature of its contents, it is not easy to conclude the object to be the praiseworthy one of supplying a text-book for students; or a readable book for adults who may have no resource but self-culture; or a book of reference for practical and theoretical men to consult, occasionally, on difficult and perplexing questions which may now and then arise in their practice.

We are open to conviction, and quite in earnest to obtain a correct conclusion on this question. We even ventured to suggest the probability that Mr. Rankine's reason, in writing the "Applied Mechanics," was to afford him an opportunity of presenting his own discoveries in a more tangible shape before the public than they were.

It is an excusable failing, and one to which most thinking men are liable, to desire the discoveries, which have been made by labour and patient thought, to arise from the dusty tomes of learned societies' transactions to the glorious privilege of appearing in "Manuals" and other elementary treatises. We can have no desire, however, to be absolute in our judgment respecting the settlement of this question. Far from it, and hence we ask ourselves the question, Does the author intend the "Manual of Applied Mechanics" to be a faithful record, not only of the mathematical principles of mechanics, but of their application to the arts as known and practised in the middle of the nineteenth century?

Recalling, then, to our memory the well-known meaning of the word "Manual"—a hand-book, a stepping-stone to a deeper knowledge, we are disposed to test the merits and usefulness of the "Applied Mechanics" in accordance with its title. And even on this ground we must at once confess the obtuseness of our intelligence to perceive its adaptation.

Having, then, no alternative, we are compelled to fall back upon the author's own statement—"The object of this book is to set forth in a compact form those parts of the science of mechanics which are practically applicable to structures and machines."

2. In what way is the object aimed at realized with respect to quality of the material used, and its arrangement?

This is a very important question in its application to any author, but we think it applies with a tenfold force to an author whose object is to be useful in instructing the young, the uninitiated, in the rudiments of science. To show them the pathway leading to the mountain-top where truth and science reign triumphantly, to make the devious steps by which the ascent is gained short and easy, are noble objects, and worthy the ambition of princes.

We shall not attempt to combat the idea that the "Manual of Applied Mechanics" is a great book—so far as its size is concerned. This point is easily settled by the astounding fact that it contains six hundred and forty pages of closely printed matter. It is divided into six parts, with a preliminary dissertation on that threadbare subject, "practice and theory."

I. Principles of Statics.
II. Theory of Structures.
III. Principles of Cinematics, or the Comparison of Motion.
IV. Theory of Mechanism.
V. Principles of Dynamics.
VI. Theory of Machines.

Each of these parts contains matter enough for a distinct treatise.

The "preliminary dissertation" on the harmony of theory and practice in mechanics no doubt contains many useful hints, which practical men would do well to weigh and consider; it should be carefully and thoughtfully read by every practical man. There is, however, one question which presses itself upon us, as it has done upon many others engaged in the practical duties of life. How is it that men of pure science are everlastingly pointing out to practical men the harmony which prevails between the knowledge and experience of practice, and the knowledge and experience of the schools and colleges? Why does not the practical man sometimes show the connection and advantage between his experience and that of the schoolmaster? Do not practical men know as much of scholastic lore as the schoolmaster and professor know of the practical manipulations of every-day life? We think they do. It is true, however, that purely scientific men can generally see, with an eagle's eye, where and when the materials they have to dispose of can be usefully applied. But, somehow or other, the obtuseness of practical men will not permit them to see the advantages and applications of science in the same light, and with the same warmth of feeling, as those whose pecuniary interest is to sell them. The professors of science sell their stock of learned lore, and practical men have to purchase it with time, labour, and money. Will this fact explain the reason why scientific men write and speak so much respecting the harmony of theory and practice? Let us remind Mr. Rankine that "theory and practice" did not depend, as he thinks they did, upon the celebrated Greek philosophers for their existence. These men only recognised them as verities—great principles inherent in the constitution of the universe—and, as such, gave them a name and locality; pointed out their legitimate uses, influences, and antagonisms, in such a manner that they are not likely to be disturbed for many ages yet to come. The ancients had no more to do with the existence of "theory and practice," than a Scotch judge has to do with justice and mercy. It is one thing to learn how to talk about the design and construction of a machine or structure; it is quite another thing to actually build it, or execute the design.

The author informs us, that mathematicians have divided the mathematical theory of a machine into two parts, with a view to enable "the engineer to compute the arrangements and dimensions of the parts of a machine intended to perform given operations." Immediately after this useful piece of information, we are strongly reminded by the learned professor that if "the engineer implicitly trusts to a pretended mathematician, or an incomplete treatise, his apparatus would come down in ruin."

Either the engineer must be a consummate mathematician to calculate the various motions and forces of which Mr. Rankine speaks, or he must engage one, if such computations are deemed necessary to the permanent stability of the structure.

It has often been a great surprise to us, that John Bull's excessive love of making money has not, ere this, induced him to engage the important and valuable services of the great mathematicians of the age in the construction of his great national works. Why does he prefer the services of distinguished practical engineers like the Stephensons, the Rennies, and a host of others, who possess not the highest mathematical genius? These celebrated men possess what is far better than the results of pure science alone—the essential and practical part of their profession. How is it, we ask, that the moneyed speculators should so far forget their own interest, and also the welfare of this great commercial nation, to allow the genius and abilities of such men as Airy, Whewell, Hamilton, Adams, Stokes, Cayley, Silvester, Rankine, Thomson, and many others, to be confined within the walls of schools and colleges in the enjoyment of very limited incomes, while they tolerate men not possessing a tithe of their abilities in the pure sciences, to make large fortunes, even in those professions in which skill in mathematics is deemed indispensable to success?

Mr. Rankine proceeds to state, "there is assuredly in Britain no deficiency of men distinguished by skill in judging of the quality of materials and work, and in directing the operations of workmen by that sort of skill, in fact, which is purely practical, and acquired by observation and experience in business. But of that scientifically practical skill which produces the greatest effect with the least possible expenditure of material and work, the instances are comparatively rare." It may be well to remind Mr. Rankine of a truth which he appears to have forgotten, or to which he attaches but little importance, viz., that the limits of minimum strength and stability of structures, and that strength and stability which the public will insist upon for their perfect safety, are frequently so large, that the nice and accurate computations to which he refers are not of that practical importance which he would fain have us believe. There is much valuable matter and many excellent suggestions in this preliminary dissertation which will repay an attentive perusal. But the author still maintains the distinction between theory and practice, and observes that "in theory the question is, what are we to think?" but in "practice, the question is, what are we to do?" We gather from all this that in "theory" and "practice," although they may travel together, the former must be subordinate to the latter. And besides, we cannot imagine a theorist wild enough to suppose he can convince the moneyed interest that theory is everything, and practice performs only a very inconsiderable part in the actual concerns of life.

I. "Principles of statics."

There can be no objection to the introduction of the principles of statics in a manual of applied mechanics, providing they are presented in a clear, readable shape, without individuality. Such a book is the last place in the world for the exhibition of such a quality. In the beginning we decidedly object to the introduction of the following formula

$$V = \iint dx\,dy\,dz$$

$$W = w\,V = w\iiint dx\,dy\,dz$$

$$W\,x_0 = w\iiint x\,dx\,dy\,dz$$

$$Wy_0 = w\iiint y\,dx\,dy\,dz$$

$$Wz_0 = w\iiint z\,dx\,dy\,dz$$

into a book, wherein it is necessary to teach the meaning of the symbols and process of integration. Such formulæ can only be of service to an advanced student in the subtlties of differentiation and integration. But if the student is not acquainted with this deep calculus—and many there are for whom this book should be useful are not,—then we are firmly persuaded there are many books better adapted to his wants than the "Manual of Applied Mechanics." In this part we observe, with some degree of surprise, a questionable departure from the general routine taught in the best and most recent Cambridge and other standard books on the subject of statics. The theory of couples is here made the basis of the lever and the parallelogram of forces, and therefore is introduced, in our opinion, out of its legitimate course and natural order.

The notation of couples adopted by Mr. Rankine is not sightly, and, what is worse, is not convenient. As a specimen, "Let two couples be denoted by A and B; let $F_A = F_B$ be their equal forces; and let L_A and L_B be their respective arms; then $F_A\ L_A$ and $F_B\ L_B$ are their moments." The affix is clumsy, and rendered more objectionable as it adds nothing to the distinctness of the idea represented. There is an evident desire to imitate the symmetrical notation of Lagrange in pure mathematics, but we regret to state the attempt is a miserable failure. We cannot see anything better than (a F) to represent a couple whose moment is the arm (a) multiplied by the force (F). Mr. Rankine's arrangement, then, with respect to couples is unfortunate, principally on the ground that considerable practice is required in the conception and management of forces and their effects, before a complete idea of a couple can be realised by the student. The idea of a couple follows naturally as a consequence of the resultant of parallel forces, but the propriety of making the resultant of parallel forces a consequence of the properties of couples may well be doubted. There are several sections devoted to a very useful and not very well known subject, viz., "Stress, and its Resultants and Centres;" and

if this subject had been treated more simply, by the aid of ordinary geometry and algebra, instead of the intricate methods of the integral calculus, its benefits would have been more universal and permanent than at present. Again, what can be the object of Mr. Rankine introducing the theory of "moments of inertia of plane surfaces" into a subject purely statical? And even the information on this subject is given in the mystical language, to practical men, of modern analysis. No one can object to the introduction of hydrostatics in a work of this kind, but when the simplest principles of that science are proved and illustrated by means of differential equations, then we conceive the usefulness of such a procedure is questionable. In a fluid the pressure varies as the depth; and the pressure is equal in all directions. These simple experimental truths are proved by Mr. Rankine by means of three differential equations. If our experience amongst students and practical men teaches us anything, it is this, viz., that the introduction of such investigations as those contained in the sections on Stress in the "Manual of Applied Mechanics," and those contained in the chapter on Modulus of Machines in Professor Moseley's "Engineering and Architecture," does great and manifest injury to the desirable union of the simplest portions of pure science with practical adaptation and experience.

II. "Theory of Structures."—In this portion there is a great deal of useful matter respecting arches, the various forms of the catenary, frictional stability, strain and strength of materials, which the student would do well to consult. But even here we apprehend there is too much importance given to subjects purely theoretical. The Hydrostatic, Geostatic, and Stereostatic arches, may afford an ample field for mathematical display: but where, we ask, is the practical man to learn anything respecting the Skew arch which railway practice has wonderfully developed during the last thirty years? The "potential energy of elasticity," "ellipsoid of strain," "transverse elasticity of an isotropic substance," possess but little practical importance amongst engineers, and therefore should have been subordinated in a "Manual of Applied Mechanics" to weightier subjects. The tensile and compressive strengths of materials, which have been investigated by Professor Hodgkinson during a period of forty years, are only referred to as of secondary importance, with a caution to the readers that "it must be obvious that much of the subject of strength and stiffness is in a provisional state, both as to mathematical theory and as to experimental data. Considerable improvements in both these respects may be anticipated from researches now in progress." Surely wisdom, intellectual power, and knowledge, will die with the professors of Glasgow University! Are we to understand, then, that the results arrived at by means of the most accurate and costly experiments, by Professor Hodgkinson, Mr. Fairbairn, Tredgold, and others, are not worthy of confidence? These experiments have commanded the admiration and confidence of every practical and theoretical man in Europe of any standing, except, indeed, Mr. Rankine.

III. "Principles of Cinematics."—It would be difficult to discover the reason why this subject should not be a part of dynamics, especially as the latter treats of the motions and cause of motions of material bodies. At all events, Mr. Rankine has not acted judiciously in explaining the first idea of motion by co-ordinate geometry of three dimensions (see page 381). However much we may differ from the Author in our notions respecting the mode of treatment of this subject, we must confess that a thorough student will be benefitted by reading those portions relating to the motion of points and rotation of bodies. We cannot think that much practical advantage can result from the discussion of such formidable equations as the following:—

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} + \left(u\frac{d}{dx} + v\frac{d}{dy} + w\frac{d}{dz} + \frac{d}{dt}\right) + \text{hyp. log. } S = 0$$

IV. "Theory of Mechanism."—There may be some useful matter here, but the practical application is, in many cases, doubtful. The obligation to Professor Willis is honourably acknowledged, as it should be; and we cannot resist our conviction that books of this kind would be more acceptable to the great majority of readers, if they were more richly referenced than they usually are. The articles on the Crank would have been improved by a careful study of Mr. Woolhouse's Paper on the same subject, printed in "Tredgold's Steam Engine."

V. "Principles of Dynamics."—Here we have the materials usually found in treatises on dynamics, and none besides. The subjects of hydrodynamics, pneumatics, and others, which have engaged the attention of the greatest thinkers of the age, are given in a form more complete than in any other volume we are acquainted with. There is, however, a constant tendency to generalise too hastily. Such a procedure may show the high intellectual power and extensive learning of the Author, but it is not always advantageous to the student: for instance, a discussion on "effort," "energy," "work of varying forces," "dynamometer," "fluid pressure," "conservation of energy," "principle of virtual velocities," "energy of compound forces," can only be a very limited illustration indeed of the first law of motion. The introduction, again, of the moments of inertia by means of the formula

$$I = \iiint r^2 \, w \, dx \, dy \, dz$$

may possibly astonish the uninitiated, without any chance of conveying to his mind much useful information. We cannot but see the contrast between this part of Mr. Rankine's labours and the lucid chapter on the same subject in "Whewell's Dynamics."

The illustrations of Whewell are simple and natural, and such that arise out of the subject of discussion. Those employed by Mr. Rankine are just the opposite. They are complex and unnatural, and not in connection with questions involving the moments of inertia. A very limited and not accurate outline of Moseley's Paper on the "Dynamical Stability of Floating Bodies" is given, and we are sure that if Mr. Rankine had consulted the best standard works on this subject, he would not have left it in such a meagre condition as he has done. Nothing, however, is better calculated to show the recklessness and caprice which have been exercised in the arrangement of the materials contained in this "Manual," than the fact of discussing the stability of a floating body—a subject purely statical—in the part strictly appropriated to the exposition of dynamical principles.

VI. "Theory of Machines."—The reader will find this part of the "Manual of Applied Mechanics" one of the best and masterly expositions of the theory of machines in our language. The whole subject is really good and practical, and no student should deny himself the pleasure and advantage of a perusal.

The term "efficiency" is here used to express the ratio between the work performed and the work applied to the machine. We are inclined to favor the adoption of this term in preference to the "modulus," as used by Moseley and other writers.

Turners' and Fitters' Pocket Book for Calculating the Change Wheels for Screws on a Turning Lathe, and for a Wheel-cutting Machine. By J. La Nicca. E. and F. W. Spon, London. Price 6d.

This little work should be in the hands of every turner and machinist, as it will be found an exceedingly useful pocket companion.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

THE RUDIMENTS OF CIVIL ENGINEERING; with plates and diagrams. By H. Law and Burnell. 4s. 6d. Weale, Holborn.

THE RIFLE CATECHISM; relating to the laws which control the flight of the bullet. By C. P. Stone. 2s. Hope.

TURNERS' AND FITTERS' POCKET BOOK, for calculating the change wheels for screws on a turning lathe, and for a wheel-cutting machine. J. La Nicca. Stitched, 6d. Spon.

THE YOUNG SURVEYOR'S PRECEPTOR, for the student to ascertain quantities, dimensions, &c. By John Rind. 16s. Thompson.

A COLLECTION OF PROBLEMS, in illustration of the principles of elementary mechanics. By W. Walton. 10s. 6d. Bell.

ART TREASURES (The) OF THE UNITED KINGDOM; illustrating sculpture, the ceramic, metallic, vitreous, textile, and other decorative arts. The text interspersed with wood engravings and chromo-lithography. By F. Bedford. Folio, £16 16s. Day.

THE ELEMENTS OF INORGANIC CHEMISTRY. By Buckmaster. Longman.

GREENER (W.) ON GUNNERY IN 1858: being a treatise on rifles, cannon, and sporting arms, describing the newest improvements, &c. Illustrated, 14s. Smith and Elder.

AGRICULTURAL CHEMISTRY: a familiar treatise. By Alfred Sibson. 1s. 6d. Routledge.

MANUAL OF ELEMENTARY CHEMISTRY. By Geo. Fownes. 7th edition, 12s. 6d. Churchill.

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]—Ed.

RAILWAY ACCIDENTS.

To the Editor of The Artizan.

Sir,—In that very interesting portion of your work, the "Notes and Novelties," I perceive the frequency with which railway accidents have of late occurred in England, but it must not be supposed that we are free from similar casualties in this country, but, on the contrary, notwithstanding the great desire of most of my countrymen to very much underrate the safety of the English system of construction and working railways, whilst they point with much self-glorification to the greater economy of construction, the more economical and profitable working, and the greater safety to travellers upon American railways, as the great features belonging to the American system of construction, I have thought it better to give you a few notes relating to the more recent accidents which have occurred, the records of which have come under my notice (but I doubt not that several other accidents have occurred) between the 1st and 28th of this month, and I have taken the following extracts from one paper only, viz., the "Philadelphia Press:"—

1st. An accident occurred at 8 o'clock p.m., on September 1st, to a train of cars on the Allegheny Valley Railway, near Hulton's Station, 12 miles above Pittsburgh. One of the cars, containing a party returning from camp meeting, was thrown off the track by a broken cross-bar connected with the brakes; the car rolled down a steep embankment, and turned over twice. At the first revolution the roof was torn off, and the passengers were scattered over the ground, mangling the bodies of some terribly; one person was instantly killed, one had his skull fractured, another his arms broken, and twenty others were slightly injured.

2nd. Albany, August 2nd.—A collision took place on the Northern Railway last night; one passenger was fatally injured, and five others badly injured.

3rd. Sept. 13th.—An accident occurred to an express train on the Steubenville and Indiana Railway, on the 10th, while passing a bridge over Cross Creek, about 17 miles west of Steubenville. The car next to the engine ran off the track, knocking out some of the main timbers of the bridge, causing it to fall. The baggage and front passenger car fell with it, a distance of 10 or 12 ft., the rear end of the train remaining on the abutment. One person was killed, and seventeen others more or less injured.

4th. An accident occurred on the 16th September on the Augusta and Savannah Railroad, about 40 miles from Augusta. The cause of the accident was the sinking of the rails, owing to the recent heavy rains. The train was made an awful wreck. The engineer and two persons were killed.

In addition to the above railway accidents, the "Philadelphia Ledger," of September the 10th, notifies a boiler explosion:—"At Mr. Foot's steam mill, about half a mile from Cambridge, Maryland, a boiler exploded on Thursday, September 2nd, completely wrecking the building in which it stood. Nobody was hurt. Damage, 1,000 dollars."

I am, Sir, your obedient Servant,
An American Engineer.

STEAM-SHIP PROPULSION.

To the Editor of The Artizan.

SIR,—Mr. Atherton's reply to my last letter is curt, but not discourteous. I have no reason to complain of it. An excusable tenderness for a cherished theory deters him from determining whether, if 1 tug tows at $1\frac{1}{2}$ miles per hour, it would require 8 tugs to tow twice as fast; and whether the tension of the tow-rope is four times as great in the latter case as in the former. Well, he has an undoubted right to decide what is most consonant with his convenience, and to prescribe the limits of his communications to the public press. Anon he may give us the benefit of his reflections, as well as of his great experience.

But what shall I say of Mr. Mansel? His last paper positively embarrasses me! When a man states that you believe in what you write, and immediately afterwards avers that you do not—when he, in total disregard of the dictionary, affirms that your avowedly free translation of a hackneyed scrap of Spanish is not in accordance with the "*heraldic*" reading, and that it is "*garrulous*" and "*wooden*"—when he insists that power unlimited is power, and that a quantity of it measured and called a horse-power is not power—when you demonstrate that the principles which form his misconceived basis of practical mechanics are at variance with natural phenomena, pronounces you in error because you do not agree with what you dispute—when he gravely urges that because a pound weight is a pound weight, it can only be the instrument of doing the same amount of "work" in the same space, however time may be varied—when he denounces you as *inconsistent* in showing that an unrestrained weight, falling through 4 ft., and *doing* no work at all, *accumulates* four times as much work as it accumulates in falling through 1 ft., under the same conditions of accelerated velocity, unless you also admit that 4 ft. of work done by the same falling weight, in overcoming the resistance of a feather, or in overcoming the resistance of 3 lb. 15 oz. of matter, are of precisely the same value—when you affirm that the aggregate accumulation of work in a free moving system is measurable by the square of its velocity, but that the period of accumulation may be unlimited, while the velocity squared is the motion of a single second, understands you to mean that the velocity itself must be measured by its square—when he gravely insists that if a 10 lb. weight and a 6 lb. weight be suspended over a pulley (the apparatus being deemed without weight and friction) and form a system of 16 lbs., the gravitating force being 4 lbs., that the generated terminal velocities of four consecutive seconds would be 4 . 8 . 12 . 16, instead of 8 . 16 . 24 . 32, and dreams that he has Newton's Principia for his authority, although space, as every dynamic student knows, would be 4 ft. the first second, and generated velocity *twice* the space, thus making it 8 ft. first second, 16 ft. the next, &c.—when you charge him with the very venial fault of viewing the subject through a "mathematical *medium*," has his imagination excited, and concludes that you refer to a communion with spirits and table-rapping—when he insists upon half the variation of *vis viva* being the measure of the expenditure of power by a body the motion of which is constant, and the *vis viva* of which, consequently, does not vary at all—when he demurs to the inertia of a body being *proportional* to its weight (which it assuredly is), and seriously directs your "acuteness" to the *obscure* fact, that *its weight* is not *its inertia*, as if any one imagined it was—when in despair he confesses that the matter he is discussing is so replete with difficulties "as to render a direct solution nigh hopeless," yet dogmatises about it, assumes "for the nonce" the editorial plural pronoun, confidently equates and formulates, and tries to smother his opponent's poor initials with an avalanche of scurrility—when he quotes Leibnitz as the author and Dr. Whewell as the supporter of his misconceptions, disregards the following passage in the latter's delightful "History of the Inductive Sciences," vol. ii., p. 68: "He (Leibnitz) maintained that the same force is requisite to raise a weight of one pound through four feet, and a weight of four pounds through one foot, though the momenta in this case are as one to two—this was answered by the Abbe de Conti, who *truly observed*, that allowing the effects in the two cases to be equal, this did not prove the forces to be equal, since the effect in the first case *was produced in a double time, and therefore it was quite consistent to suppose the force only half as great.** Leibnitz, however, persisted in his innovation, &c." When all these mental phenomena are exhibited, the futility of further argument is manifest; commiseration disarms antagonism, and you become prompted to express what you *feel*, rather than what you *think*.

Your readers will perceive that the above is a synopsis of Mr. Mansel's last paper. If any of them will collate it with that paper, and subsequently read mine, published in your July number, they will be able to arrive at a pretty accurate conclusion as to our respective opinions. I think, without being in the slightest degree "be-muddled," they will agree with me:—

That if a descending 1 lb. weight in one case causes 16 lbs. of matter to move through 1 ft., and in another case causes 8 lbs. of matter to move through 2 ft. in the same time, that the aggregate of work done is the same, and that, therefore, 1 "ft. lb." in one case, is equal to 2 "ft. lbs." in the other. And this will be done if we put two $7\frac{1}{2}$ lbs. weights upon one pulley, and two $3\frac{1}{2}$ lbs. weights upon another. If a 1 lb. weight be added to one side of each system for one mass, $7\frac{1}{2} + 7\frac{1}{2} + 1 = 16$ will move through 1 ft. in a second; and the other mass, $3\frac{1}{2} + 3\frac{1}{2} + 1 = 8$, will move through 2 ft. in a second: the 1 lb. weight doing the work in both instances, as the other weights respectively neutralise the action of gravity upon each other. Of course, the inertia and friction of the pulleys have to be compensated for.

The following Table may be of service:—

16 lb. Mass moved from rest by 1 lb.					8 lb. Mass moved from rest by 1 lb.				
Seconds.	Terminal velocity per second.	Average velocity during the second.	Space passed through in the second.	Total space passed through.	Seconds.	Terminal velocity per second.	Average velocity during the second.	Space passed through in the second.	Total space passed through.
	ft.	ft.	ft.	ft.		ft.	ft.	ft.	ft.
1st	2	1	1	1	1st	4	2	2	2
2nd	4	3	3	4	2nd	8	6	6	8
3rd	6	5	5	9	3rd	12	10	10	18
4th	8	7	7	16	4th	16	14	14	32
5th	10	9	9	25	5th	20	18	18	50
6th	12	11	11	36	6th	24	22	22	72
7th	14	13	13	49	7th	28	26	26	98
8th	16	15	15	64	8th	32	30	30	128

Squares of velocities of the 16 lb. Mass.	4	16	36	64	100	144	196	256
Total spaces	1	4	9	16	25	36	49	64
Squares of velocities of the 8 lb. Mass..	16	64	144	256	400	576	784	1024
Total spaces	2	8	18	32	50	72	98	128

Thus the total spaces passed through vary in the ratio of the *square of velocity;* and this, of course, will be the measure of work accumulated or expended at any instant while accelerated or retarded motion is going on. But the space passed through in any second is the average velocity of that second, and as this velocity simply is the measure of the space, so also it is the measure of the work accumulated or expended during the second. Now 10 ft. is of ten times the value of 1 ft. *in each case;* but both the 10 ft. and the unit of one case are of a different value from the 10 ft. and the unit of the other.

Your mathematical readers will perceive that, to render the ordinary dynamic equations and formulæ applicable to the above cases, the value of the symbol or coefficient "g" (which is $32\frac{1}{6}$ when the mass moves unrestrainedly) becomes 4 with the 8 lb. mass, and 2 with the 16 lb. mass; and they will also perceive that, if the motions of the two masses be conceived of as reversed, so that the preponderating 1 lb. weight should be opposed to gravity, and the terminal velocities become the initial velocities of ascent, that *both masses would become quiescent in the same time, although one has twice the velocity of the other:* whereas in a free system, with a double velocity, ascensional force is quadruple, *and the time required to produce quiescence is double.* The importance of not confounding essentially different phenomena will also, no doubt, occur to them.

In this illustration we have *accelerated* motion; but if we take the transit of a body through a fluid, the increment of resistance, after a time, becomes greater than the increment of acceleration, when increase of motion ceases, and velocity becomes constant. Now it is a convenient fact, that a 1 lb. weight will pull a plane of 1 ft. area through about 1 ft. in a second of time. If the plane be reduced to 6 in. sq., its area will be only one-fourth of what it was; the 1 lb. weight will pull this reduced plane through 2 ft. in a second, and the motion will be unvarying in velocity. If measured by the pressure × space theory, the smaller plane expends twice the amount of power that is expended by the larger one; but common sense, measuring work by resistance overcome, and seeing that one plane *ab initio* only encounters one-fourth of the resistance of the other, concludes that the same pressure acting upon both will equilibrate the work done in the same time, by increasing the space which the smaller passes through per second till this is accomplished. Thus the resistance overcome in any finite time being as the square of velocity, and putting A = area and V = velocity, we have—$A\ V^2 = 144 \times 1^2 = 144$ for the larger plane, and $A\ V^2 = 36 \times 2^2 = 144$ for the small plane; 1 ft. of work on the larger plane being equal to 2 ft. of work on the small one with the same pressure.

Again, to bring the matter to the test of practical mechanics, put a pressure of 6,000 lbs. upon a screw shaft in the new Derrick vessel, instead of her paddles, and perhaps she will move through the water 2 miles per hour. Apply the same pressure to a steam-packet, and it will give her a speed of 10 miles per hour. As the pressure is the same for both, the theory disputed gives the power expended by the Derrick vessel as one-fifth of that expended by the packet in the same time. I apprehend if the experiment were tried, and the coal-bunkers consulted at its termination, it would be found that the source of power had diminished nearly the same in both vessels.

Mr. Moseley states "that a stone, as it falls *in vacuo*, no more WORKS than do the planets as they wheel *unresisted* through space." He is right. Mr. Warr, in his valuable treatise, says "the principal element which distinguishes dynamics is TIME." He is right also. *Work* cannot be truly estimated when *resistance* and *time* are ignored. Moving pressure and

---

*Huygens first laid down the principle that "bodies constantly preserve their ascensional force—that is, the product of their mass into the height to which their centre of gravity can ascend, *which is as the square of their velocities.*" This principle was designated *conservatio virium vivarum.* There can be no doubt of the soundness of this principle, however it may be designated. Leibnitz did not *invent*, but ADOPTED it. And the forces in the above weights are estimated by it, for their ascensional forces respectively would be in proportion to the spaces through which they must have fallen from rest to acquire them. The 1 lb. must have fallen 4 ft., and the 4 lb. 1 ft. But, as objected to Leibnitz, by the law of gravitation the 1 lb. must have required half of a second for its fall $\left(\text{for } t = \sqrt{\frac{2s}{g}}\right)$ and the 4 lb. weight only a quarter of a second. If the same weights were projected vertically upwards with those forces, the 1 lb. weight would require twice the time of the 4 lb. weight to lose its force. The initial velocity would $= g\,t$, or about 16 ft. per second for the small one, and about 8 ft. per second for the large one; and the momenta would be, as Leibnitz states, as $(4 \times 8) : (1 \times 16)$, or as 2 to 1. The *whole* ascensional force lost would be *as the square of velocity.* The ascensional force lost *per second* would be *simply as the velocity.*—G. J. Y.

velocity alone are not sufficient data. The falling stone may weigh a pound, and, if so, the profound "cube theorists" inform us that its *work* in falling through a foot is invariably a "foot-pound," the value of which is constant. It matters not whether its fall be through a foot of mercury, a foot of the dense water of the Dead Sea, a foot of the earth's atmosphere, or even through a foot of the most tenuous part of the comet's tail. The energy of gravity is the same in each case; the space fallen through is the same; *but why is more time required for one transit than another, if the work is the same in all?* This the "cube theorists" *do not* inform us. Nor do they explain how it is that two pressures counteracting each other can be varied in the same ratio, and the velocity of the body acted upon be doubled in consequence. Although this explanation must be given, or their theory must fall.

I have the great gratification of receiving from some of the most eminent scientific men corroborations of my objections to the pressure × space theory. I feel assured that the advent of a true theory is at hand; and if I have been instrumental in dispelling a little of the mist which obscures its rising, or have induced scientific men to give the matter an additional thought, my scribbling has not been in vain.

G. J. Y.

"DEANE'S MANUAL OF FIRE-ARMS."

To the Editor of The Artizan.

Sir,—I trust your sense of justice will cause you to insert my reply to the attack on my breech-loading rifle contained in the review of "Deane's Manual of Fire-Arms," in the last number of The Artizan. By referring to my patent of February, 1855, you will find the plan called Terry's distinctly portrayed and described in the second part of my specification, being the reverse of the plan which from long experience I have found preferable both in utility and appearance. The only difference consists in the lever, which in mine stands upright; in Terry's, folds into the opening for the cartridge. The said alteration, however, was patented in England by Monsieur Manceaux, of Paris, some months before Mr. Terry's patent is dated, viz., the 7th April, 1856. A more positive proof, however, of the soundness in mechanical principle of my gun over Terry's could not be procured than that obtainable from the proof-master in relation to breech-loading guns on the French system, so many of which have come into use for sporting purposes this season: when sent to proof unsupported, they broke one after another; but when recourse was had to a wooden block or stock, the reverse was the case. The above proves the truth of the standing rule with gunmakers, that a "head" was necessary in forming a sound gun. Indeed, for truth of mechanical construction, no disinterested gunmaker for one moment hesitates in awarding mine the preference.

Your reviewer refers to Lieutenant Hans Busk's work on the Rifle in favour of his opinion respecting the merits of Colt's *v.* Adams's revolvers. The same author states, in the chapter devoted to Terry's breech-loading rifle: "A carbine on this construction, ·577 bore, sent to me for trial, did not load with the same facility as one of Prince's rifles, nor was its accuracy of fire at all comparable to that of the latter weapon."

If Mr. Terry, or any friend of his, wishes to test his rifles against mine, and will use a common paper cartridge (unassisted by a wadding at the back), such as a soldier only could make up in a case of emergency, I will undertake to "shut up" six of his rifles before one of mine shall stop in action, no cleaning to be allowed; while, if he uses a wadding, I will undertake, with the same weight and bore of rifle, and the same charge of powder and weight of bullet, to get 400 yards longer range, and a much lower trajectory (a most important feature in either a military or sporting rifle); and, with shot, to go through more sheets of paper at 60 yards than he can at 30 yards.

Yours, &c., F. Prince.

ERRATUM.—In our last Number, page 251, in Letter signed "Chas. Atherton," *for* "the formula $P \times V^3$" *read* "the formula $P \propto V^3$."

NOTICES TO CORRESPONDENTS.

R. C. (Glasgow.)—Mr. Woodcroft's subject-matter index under the old law is incorrect in the particular instance referred to, although the Indices of Patents both under the old and new law are generally correct. Mr. Andrew Smith was the first patentee for the manufacture of wire-rope; although in the second division, under the head "Rope Manufacture," at page 648, the date of the first patent for making wire-ropes was 7th August, 1840 (No. 8594), whereas the patent granted to Mr. Andrew Smith, and J. L. Hood, was dated 26th March, 1836 (No. 7044). There is also a second patent granted to Andrew Smith, dated March 20th, 1839 (No. 8009), both anterior to the 7th August, 1840, and both refer exclusively to wire-ropes as a substitute for hempen-ropes. Why they are omitted in the list of patents for making wire-ropes we cannot inform you. To your second question, we are enabled to reply as follows:—First, Messrs. Wright, of Birmingham, are making the compound hemp and wire ropes at works which they have established at Millwall, Poplar, and they have, at our request, furnished the following particulars of some tests that were made at Mitcheson's chain-cable testing machine at Rotherhithe. We cannot, of course, vouch for the correctness of the tests, but comply with your request.

Result of the Tests of Patent Compound Wire and Hemp Rope, compared with Wire Rope and Hemp Rope.

Patent Wire and Hemp Rope.				Wire Rope.		Hemp Rope.	
Weight per Fathom.		Broke at		Breaking Strain at same Weight per Fathom.		Breaking Strain at same Weight per Fathom.	
lbs.	oz.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
2	13	8	10	3	10	2	10
3	11	10	0	5	10	3	10
6	0	11	10	8	0	6	7
8	10	16	0	13	10	8	5

Weight per Fathom and Size of Patent Wire and Hemp Rope, compared with Wire Rope and Hemp Rope, each to take the same Breaking Strain.

Patent Wire and Hemp Rope.					Wire Rope.			Hemp Rope.		
Breaking Strain of each.		Circumference.	Weight per Fathom.		Circumference.	Weight per Fathom.		Circumference.	Weight per Fathom.	
Tons.	Cwt.	In.	lbs.	oz.	In.	lbs.	oz.	In.	lbs.	oz.
8	10	3	2	13	$2\frac{3}{4}$	6	8	6	9	6
10	0	$3\frac{1}{2}$	3	11	$2\frac{7}{8}$	7	0	$6\frac{1}{2}$	10	8
11	10	$4\frac{1}{4}$	6	0	3	7	6	7	12	0
16	0	5	8	10	$3\frac{3}{4}$	10	6	$8\frac{1}{4}$	14	4

For cost, compared with other rope, it will stand thus:—Say, required 120 fathoms rope to take breaking strain of 10 tons.

Patent Wire & Hemp Rope, $3\frac{1}{2}$ in., 120 fms., tarred, 4cwt. 2qr. 12lbs., at 48s., £11 1s. 2d.
All Wire .... $2\frac{7}{8}$ in., 120 fms., galvnzd., 7cwt. 2qr. 0lbs., at 45s., £16 0s. 6d.
All Wire .... 6 in., 120 fms., tarred, 11cwt. 0qr. 24lbs., at 36s., £20 3s. 10d.

As to your third question, nearly the entire of the submarine telegraph has been made by Messrs. Newall and Co., and Messrs. Glass and Elliott; but we perceive, by the "Times," City Article of 25th October, Mr. Henley, of Greenwich, has completed 240 miles to connect the Island of Tasmania with Victoria, Australia. The weight of this cable is 2 tons per mile. We believe it is a single conducting wire, insulated with gutta percha, which after being served over with a coating of hemp saturated with a mixture of tar and tallow, is protected with an outer covering of ten iron wires. Newall and Co. and Glass and Elliott have both excellent machinery for telegraph cable-making, and have equally high reputation.

G. W., Nottingham.—We now learn that there is at present no manufacturer in Nottingham of the machines respecting which you inquire; but a Nottingham correspondent informs us that the best maker is Mons. E. M. Dury, No. 24, Rue Montorgueil, Paris. The price of the machine in Paris is, we are informed, £10.

Q., Glasgow.—The machine for punching the cards for the jacquard loom apparatus, which was exhibited in the Great Exhibition of 1851, has, we are informed, been made more comprehensive, and is now perfected. We are informed that it enables one operator to read-in, punch, number, and repeat with perfect accuracy between 60 and 120 cards per hour, according to the character or fulness of the pattern. The inventor, Mr. Duncan McKenzie, has laboured at this invention for ten or eleven years, and has not until now succeeded in perfecting the machine.

T. E. F., Charlotte Street.—We advise you to purchase from Mr. Weale, bookseller, High Holborn, one or two of his sets of rudimentary works relating to the subject respecting which you make inquiry. We scarcely believed it possible for any one possessed of even a moderate amount of school knowledge to be so thoroughly ignorant of a subject that has been so popularized. As you request an answer to the query not alone on your own behalf, but also on behalf of others, we have to inform you that the screw propeller is fitted upon a shaft lying horizontal, or nearly horizontal, and that the shaft and the propeller revolve together. The motion is a continuous circular motion, and not a vibratory motion.

J. D.—Mr. B. Woodcroft, of the Patent Office, published a very useful work, containing an abridgment, relating to the various instruments for propelling vessels, to which we refer you. There are two parts, price one shilling each.

Roberts' Friction Windlass (Jarrow).—The date of Roberts' patent is, we are informed, May 22nd, 1852. Mr. Roberts introduced grooved pulleys for pillar windlasses nearly 30 years ago.

R. Burn.—We will make inquiry, and endeavour to reply in our next.

Answers will be forwarded by post to S. N., J. C. B., R. Hewlett, T. Jackson, and P. Q., if they will forward their addresses.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we purpose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar and intelligible shape.—Ed.

The Fatal Collision on the Oxford, Worcester, and Wolverhampton Railway.—This inquest (on thirteen of the sufferers) was, after a perhaps unprecedented series of adjournments, brought to a close, on the 5th October ult., by the Jury unanimously returning a verdict of "Manslaughter" against the guard of the train, and annexing to their verdict their opinion that "there is gross insubordinate conduct by the station master, and apparent unconcern in the higher authorities throughout—that sufficient care is not used in selecting the materials required, such as chains, shackles, &c., as to quality and workmanship—that there is irresponsibility of officials in every department of the Company, from the highest to the lowest—and that a sufficient number of servants are not employed at the various stations to ensure the safety and comfort of the public." As though to complete the perplexities and complications of this painful and remarkable case, a protest against the opinion attached to the verdict has since been entered by four of the Jury, who have published a letter in which they say, "We consider the imputation of gross insubordination on the part of the station-master, and the apparent unconcern of higher officials, not warranted by the evidence; and the second charge, that sufficient care is not used in selecting the materials required for chains, &c., is contrary to the evidence produced before us, and is a gross libel upon the managers, engineers, and scientific witnesses, brought before us during the enquiry."

The Recent Fatal Gas Explosion at Colonel Greville's.—It was not till the 18th October ult. that the resumed inquest on the sufferer by the accident on the 13th September last, was brought to a close. The Coroner said "it was a very lamentable case, and the evidence was very unsatisfactory. He thought that the public could not be too well informed of the dangerous character of such works." The Jury returned a verdict of "Accidental Death," and expressed their belief that there had not been sufficient caution on the part of the gasfitter. The Coroner said, the gasfitter ought to have represented to Col. Greville the impropriety of leaving such a duty to a female servant.

BREACH OF COLLIERY RULES.—At Stoke, the manager and brother of the proprietor of the Railway Colliery, Fenton, Staffordshire (where an explosion of fire-damp last July resulted in the death of three men) was charged with a breach of the 23rd special rule, requiring the manager of a colliery to see that the "stoppings" are made of brick and mortar, whereas the defendant had allowed a "stopping" in a main air-course to consist of a sheet only. He was convicted in each case.

LIABILITY OF ENGINE DRIVERS, FIREMEN, &c.—In the case of the collison on the Exeter and Bristol Railway, alluded to in our present Notes and Novelties, the engine-driver and fireman were respectively brought before the Mayor of Exeter, at the Guildhall, 20th October ult. From the evidence adduced it appeared that the morning was very dark and rainy, and on nearing Cowley Bridge, near Exeter, the red danger-signal was visible, as well as two other danger-signals nearer the station. The engineer sounded the whistle for the breaks to be applied: this was done by the inspector and a porter. It was stated that the train was going at a speed faster than usual on nearing the station, and that was the reason it could not be arrested. On the other hand it was urged that the metals being wet, the breaks could not be brought to bear with proper force; if they had been, no collision would have occurred. In consequence of the good character given to the defendants, who had been long in the Company's employ, the Bench inflicted the mitigated penalty of £5, with the alternative of a month's imprisonment.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

WE have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE SMOKE NUISANCE.—The proprietor of some extensive sawmills in Bromley has recently been fined £5 for not using a smoke-consuming apparatus; and the premises are placed under the surveillance of the police, in order to enforce the provisions of the act.

METROPOLITAN DRAINAGE.—From the Report of the Engineer to the Metropolitan Board of Works it appears that the main-drainage system is to be separated into two great departments, by the course of the Thames. On the north side of the river, three main sewers on three levels, called the high, middle and low level respectively, are to be constructed; on the south side two sewers only are projected, one on a high and the other on a low level; and each side of the stream besides will have its main outfall-sewer and its reservoir. The work resolves itself into ten great portions—five to the north of the Thames, four to the south, and one at the West-end. The cost of the three main-sewers (north) are put at £585,000; outfall sewer at £464,000; reservoir, £150,000; southern system, £355,000 for its sewers, £372,000 for its outfall, and £90,000 for its reservoir; western sewers, £55,000.

NEW MATERIAL FOR ROAD-MAKING.—In France a new system of road-making has just been introduced with, it is said, complete success. The first trial has been made on part of the Place du Palais Royal. A quantity of concrete, about 5 in. in thickness, is first spread out, and on that is applied a layer of bitumen, reduced to powder, and in a boiling state. On this latter, which is also about 5 in. in thickness, a quantity of river-sand is sifted, and then the surface is pressed down by a heavy cast-iron roller, weighing about 2 tons. In a few hours afterwards, the road thus made may be passed over by the heaviest waggons, without the slightest impression being left by the wheels. The same system is being applied to part of the Rue St. Honoré (between the Palais Royal and the Rue de Richelieu).

In this alleged new system, the chief point of difference from the usual asphalte and other bituminous pavements would appear to be the introduction of a concrete foundation; the subsequent enormous pressure applied may possibly supply a new element of endurance in this class of roads, which hitherto have failed, confessedly, in this indispensable quality.

MACHINERY (FOR MONTE VIDEO) DUTY FREE.—Amongst the exemptions from import duties specified in the law recently enacted by the Government of Monte Video, official notice of which, by the Board of Trade, is announced in the "London Gazette" of October 21st ult., are—Art. 13. "Large machines, for the use of agriculture and industry, and improved ploughs; every kind of steam machine whatever be the use for which it is designed; machines or apparatus which may serve to construct, improve, or keep the roads in order, to clear roadsteads or ports, to open and keep channels for navigation, and improve those of the rivers; the steamers which may come in pieces to be put together in our (Monte Videan) ports and rivers, surgical instruments, machinery and apparatus destined for the study of mathematics and natural sciences, printing machines, and the paper for their use."

NEW CURB-BIT.—M. Chambon, of Toulon, has introduced an entirely new kind of bit for the subduing of restive horses. His invention is based on the principle admitted, as he asserts, by all riders, that the various contrivances hitherto in use, being applied to the most sensitive part of the horse, namely, his mouth, are all, more or less, the actual predisposing causes of the indocility and restlessness of the animal. For the usual *mouth-bit*, therefore, he substitutes a *nose-bit* ("*mors-nasal*"), consisting of two plates or metal discs adapted to the double-reined bridle, the ordinary leading-rein, and the safety-rein. These "branches" or discs are so placed as to press on the nostrils of the horse whenever the rider draws in the safety-rein; thereby instantaneously and totally stopping respiration without otherwise injuring the animal, as by cutting his tongue or mouth, &c., as in the old methods. The inevitable result of the new method is stated to be the instantaneous stoppage of the horse, even under circumstances of the most imminent peril; whilst the alleged advantages are the avoidance of constant irritation and uneasiness to the animal (the plates or "branches" never touching the nostrils, except in exceptional cases of rare occurrence).

AN OVERLAND MAIL-ROUTE TO SAN FRANCISCO has been opened. It consists of a waggon-track of 2,701 miles from St. Louis. Contract-time, 23 days 14½ hours. Passenger fare, £40.

VENTILATION OF BARRACK ROOMS—NEW APPARATUS.—The plan, which has received the sanction of the War Department, and which has been put in practice at the Chatham Barracks, where it is said to have perfectly succeeded, consists of an apparatus the details of which are exceedingly simple. At the side of each fire-place a large square wooden shaft is erected, running from the ceiling of the room to a point clear of the outside of the roof. This shaft is sufficiently large to carry off, in a powerful current, all the impure air engendered in the barrack-room, and its capacity gives an average of 8 sq. in. to each occupant of the room. Fresh air is supplied to each room by incisions made in the outer wall, which are then fitted with the ventilating irons, placed on a slight angle, and covered with perforated zinc. The advantages of this plan are, that although a current of cold air rushes in to supply the place of that carried off, yet the persons in the room are not inconvenienced, as the angle by which it is admitted prevents its pouring down on the heads of those below. The rooms on each floor are supplied with a separate shaft, all communcating with a square apparatus on the roof. Experiments have been made with the new apparatus (erected by Messrs. Foord, of Rochester, under the direction of Col. Williams), and it is believed that the same system will be generally adopted throughout England.

BELL-FOUNDING.—The third quarter bell for the Westminster clock, recast, has been delivered by Messrs. Warner, and the whole peal approved of by the referees. They are to be hoisted immediately.

THE NEW PEAL of the new parish church at Doncaster (designed by Mr. Denison, Q.C.), has been hung, and, on trial, pronounced to be sweet and brilliant in tone. It has been cast on a new principle in several respects, especially in the large bells being much heavier than usual for their note, and in proportion to the smaller ones. The tenor is exactly half the size of the new Big Ben, and very nearly of the same shape and composition. It weighs 30 cwt. 1 qr., and the note is E flat, concert pitch: the treble, an octave higher, is 6½ cwt. The casting (by Messrs. Warner) is adjudged by connoisseurs to be good.

FATAL ACCIDENTS FROM MACHINERY.—York, 29th Sept. ult.—An inquest was held at the County Hospital on the body of a labourer, who had been employed at Wiggington Bar serving a thrashing machine, when one of his legs became entangled in the machinery, and it was severely crushed. Symptoms of lock-jaw eventually set in, from which he died. Verdict, "Accidental Death."

AT SHEFFIELD (24th September ult.), a little girl employed at the Don Cutlery Works, Doncaster-street, Sheffield, in passing the shaft which connects the steam-engine with the machinery, then revolving very rapidly, the end of the shaft caught against her clothes and whirled her round with terrific violence. The men instantly stopped the engine, but the poor girl, fearfully smashed, and her clothes torn to shreds, was quite dead. Surely some compulsory preventive measures ought to be forced on the owners of machinery to guard against the recurrence of these tragedies, now so frequent.

RAISING OF THE GREAT "VICTORIA" BELL AT WESTMINSTER.—On the 7th October ult., the work of raising this bell to the summit of the "Albert" or clock-tower, at the new Houses of Parliament, was commenced. The bell, placed on its side upon a cradle, was run into the basement of the Albert tower, and placed under the shaft extending to the summit of the tower up which the bell is to be hoisted. This shaft is 11 ft. 2 by 8 ft. 6 in. It is intended for the descent of the clock-weights. Its sides have been lined with timber, and friction-wheels to guide the passage of the bell. The lifting chain is 1,600 in length, expressly made by Messrs. Crawshay, of Newcastle, and each link separately tested. The beam on which the Victoria bell will be hung is formed of oak and plates of iron firmly bolted together. It is fixed in the open lantern over the clock, is 25 in. wide and 19 thick, and capable of sustaining 100 tons. The bell is to be raised by easy stages. The completion of the clock and of the chimes will, it is understood, not be delayed beyond a few weeks. On the 14th October ult. (about half-past 2 o'clock a m.), the great bell was safely landed in its final destination in the clock-room, amidst the hearty cheers of the workmen.

THE NEW YORK CRYSTAL PALACE, with all its contents (including a large collection of mechanical and agricultural implements, steam-engines, &c.), has been destroyed by fire—at present, believed to have been incendiary. Upwards of 2,000 visitors were present at the time.

RAILWAYS, &c.

AMERICAN RAILWAYS—According to a recently published (American) treatise of admitted weight and practical authority, the annual expenses of operating the American lines amount to 120,000,000 dollars, whilst the cost of operating the English railways for the same mileage is but 80,000,000, "the difference being nearly equal to the annual production of the gold mines of California." The expense of maintenance of the American lines is from 31,000,000 to 35,000,000 dollars annually; that of English lines, for same mileage, 12,500,000 dollars—difference, say 20,000,000 dollars annually. The cost of fuel for the former is 18,000,000 dollars yearly; that of the latter, for the same mileage, is but 7,500,000 dollars, or 10,500,000 dollars against the American system. The first cost of the road-bed and superstructure (or the "permanent way") of the European lines is somewhat greater than for those of America; whilst the expense of the former per mile run, for maintenance of way, is but two-fifths that of the latter (America); and their consumption of fuel, for equal mileage, is less than sixty per cent. of the quantity burned in the American locomotives. The earthwork of American lines is only from 25 to 28 ft. at formation level for double track, whilst that of the English lines is 33 ft. The slopes of cuttings and embankments are very deep, say 1 to 1, and seldom protected by grassing or turfing. Scantiness of earthwork, want of ballast (entailing the necessity of constant packing and surfacing), and deficiency of drainage, are the admitted defective points in American railway construction. The sleepers are small, of irregular sizes, and laid often so closely as to prevent proper packing, never protected by chemical preservatives, and last only half as long as the English ones. The rails are light, notoriously of very bad materials, and last only in the same proportion. No adequate system of support at the joints, while the fastenings also are generally such that the rail does not lie quietly. On the Erie railway, for a given length of time, one-half of the joints at the rail ends averaged 1½ in. open, several were 2½ in. open, and some were actually found separated 3 in. and even 3½ in. at the ends. The effect of this state of things on the ease of travelling, and the durability both of way and of rolling stock, may be readily conceived.

RAILWAY-GUAGES IN THE UNITED STATES.—Of these there are no less than six different sizes on the American lines, namely, 4 ft. 8½ in., 4 ft. 10 in., 5 ft., 5 ft. 4 in., 5 ft. 6 in., and 6 ft. In one part of the west a "compromise" has been made, and the equipments of the 4 ft. 8 in. and 4 ft. 10 in. guages *run together* upon one of 4 ft. 9¼ in.

ATTEMPT TO UPSET A RAILWAY TRAIN.—A boy, aged 14, has been committed by the Abergavenny magistrates for trial at the assizes, for attempting to throw a railway-train off the rails, near the Pandy station, on the Newport and Hereford line. The accused was seen on the Sunday evening to go to the points, force them open with a stick, and place stones between the rails. Happily no bad result occurred, the impetus of the "train" carrying it over the obstacle. Two years ago a similar case occurred in this district.

THE "OTTOMAN" TURKISH RAILWAY (Smyrna to Aidin).—The directors have determined on making the first 40 miles of this line (from Smyrna to Ephesus) as soon as possible. The entire line as projected is 70 miles in length, but for convenience of execution and to expedite traffic it is to be divided into three sections. The second section commenced at Ephesus, is 8 miles in length, and the third section (about 22 miles) to the city of Aidin. The heaviest works on the first section have been on the first 10 miles of it. Earthworks in an advanced state. Rails and sleepers delivered on the line. First section expected to be completed for traffic by the autumn of next year. A tunnel on the second section will take two or three years to complete. Works on the third section light, and might, if

requisite, be completed in twelve months. Part of first section has been ballasted, and the permanent rail laid for upwards of 2 miles. Works on remaining 32 miles of second section generally light. A temporary wharf has been constructed at Smyrna for landing materials. Two locomotives have been landed, and are now working on the line. Estimated cost of the line about one-fourth or one-fifth of the cost of railways in England. Intended principle—that of carrying the largest number of passengers at the lowest rates. Traffic data—The imports of Smyrna for one year (1857) amounted to £2,535,000; exports, £2,487,000. Number of vessels that visited the port of Smyrna in that year was 1,750; tonnage, 437,000. Population of Smyrna 160,000, and of the city of Aidin 30,000. Present cost of carriage of merchandise from the bazaar at Aidin to Smyrna (72 miles) £3 10s. per ton, or about 1s. per ton per mile.

Australian Lines.—The Geelong and Ballarat works (contractors, Messrs. Evans and Merry) were to be commenced on the 16th Aug. ult.

The Melbourne and Suburban Railway Company have commenced their work, and have completed a fair portion of their permanent way.

The Hudson's Bay Company are having the course of their permanent way at the Melbourne end diverted, in order that the awkward curve which occurs at the commencement of the line may be avoided. A new bridge has been thrown over the Yarra, for the purpose of connecting the new work with the opposite bank.

Sydney.—The Legislative Assembly has recently voted £712,000 for the extension of railways to Penrith, Picton, and Singleton, by a majority of five to one. The new lines are to be proceeded with immediately. The vote is expected to provide for 60 miles of new railway; 20 to the south, and as much to the north and west. One-third of the work is to be thrown open at once to satisfy the colonial contractors, and the refusal of the residue is given to Sir M. Peto.

London and Blackwall Railway.—The traffic on this line was temporarily interrupted by the loosening (by fire) of the brickwork of some of the railway arches near the West India Docks. The stores of Messrs. Westropp, ship riggers, and of Messrs. Bell and Wright, also ship riggers, occupied the works extending under five or six of the arches of the railway. In the afternoon of the 1st October ult. a fire broke out in these stores, each department of which was stored with ships' rigging, ships' furniture, and a great quantity of machinery. The heat became so great as to loosen the brickwork of the arches, and it was found necessary to put a stop to all trains up or down the line.

The Namur and Liege Line has been disposed of to the Great Northern of France.

The Mons and Menage has been made over to the Belgian Government, a fixed dividend having been secured to the proprietors.

American Railway Accident.—On the Steubonville and Indiana railroad (night of the 10th September ult.), while the train was crossing a bridge, 17 miles west of Steubonville, a car and the rear engine jumped from the track, causing the bridge to give way. The baggage and first-passenger cars went down, but the others remained on the bridge. One person was fatally injured, and about twenty others more or less hurt.

Railways in the United Kingdom.—Of the 9,116 miles open for traffic on the 31st December, 1857, 6,777 miles are in England, 1,269 in Scotland, and 1,070 in Ireland. 7,053 miles are constructed on the narrow gauge, 740 miles on the broad gauge, 261 miles on the mixed gauge, and 1,062 miles on the Irish gauge. There are 2,775 miles of single line, of which 1,797 are narrow gauge, 255 broad gauge, 72 mixed gauge, and 651 Irish gauge. Length of new line reported (to Lords of Privy Council for Trade on Railways for the year 1857) to be in course of construction on the 30th June, 1857, was 1,004 miles; of these about 23 miles were opened before the end of 1857; number of persons employed on them 44,037, being, on the average, 43·86 persons per mile. Length of line open for traffic in the United Kingdom, on 30th June, 1857, was 8,942 miles, and the persons employed thereon amounted to 109,660, or 12·26 per mile. Number of stations, 3,121. Capital raised for construction of railways on 31st December, 1857, £314,989,626, representing an expenditure of £34,950 per mile of railway open. The cost of railways in the United Kingdom averages £34,950 per mile—viz., £39,275 in England, £28,225 in Scotland, and £15,664 in Ireland.

Collision at Exeter.—On the morning of the 19th October ult., the down mail arrived at the Exeter Station of the Bristol and Exeter Railway. At the platform, the engine, post-office tender, &c., were taken off in the usual way. The engine was on South Devon Bridge, putting back the Post-office train on to the platform, when a train, containing soldiers to Plymouth, approached the station at unusual speed. The switchman, seeing a collision inevitable, signalled the mail-train to go ahead. The troops'-train, however, ran into the mail-train carriages standing on the platform. The carriages were driven on to the South Devon Bridge, and again came into collision with the Post-office tender. In consequence, seven persons (among them, three convicts, a mail-guard, and a soldier) received contusions. No blame, it is said, is to be attached to the officials of St. David's Station, as signals were all showing danger at the time the troop-train arrived, and the switchmen were at their posts. The station-superintendent has placed the engine-driver and stoker of the troop-train in custody, to await a judicial enquiry.

Guard and Driver Alarum.—The Scottish North-Eastern Company have commenced placing on their engine-tenders, &c., an apparatus which establishes communication between the guard and engine-driver. To a bell fixed to the tender is attached a line, which reaches to the guard's van; the latter has only to turn a wheel in order to strike the bell, which is a signal for the driver to stop the engine.

Railway Train on Fire.—On the 25th September ult. a train caught fire on the South Wales railway, near Cardiff. One of the carriages contained eight or ten valuable rams, and the poor animals were hurnt to death, the fat from their carcases running out upon the line in a state of ignition.

Collision through (alleged) Wilfulness.—As the passenger train for London was leaving Preston, at 10 o'clock on the night of the 25th September last, it came into collision with the goods train. Several persons were injured, engine disabled, and two waggons smashed. The driver is said to have left the station in opposition to six danger signals.

Railway Companies' Association.—Delegates from the principal railway companies met at the Euston Hotel, London, on the 7th October ult., to organise a permanent "Conference of Delegates," to whose final decision, by way of arbitration, all future disputes and misunderstandings between rival companies are to be submitted. Their first proceeding was by no means of promising augury. A debate upon a motion that reporters be admitted ended by a vote of twelve companies to eight "that the doors remain closed."

Buffalo and Lake Huron Railway. — The western division of this line to Huron Road, Goderich, has been opened. Although the Government Inspector has pronounced this road safe for traffic, and both passenger and goods trains are freely run upon it, still it is not absolutely complete, and some works have yet to be accomplished. On the eastern division, also, works are still in progress for ballasting the line, repairing bridges, and filling in trestle work with earth. Up to the 28th June last, only 114 miles were in operation; this was previous to the extension to Huron Road. The Directors are sanguine in the hope that there will soon be a terminus at Buffalo and Goderich Harbour, at each end of the line.

Great Western of Canada. — The loan of £150,000 by this Company to the Detroit and Milwaukie, to enable the latter (Canadian noncompeting) to finish their line and accommodate the traffic, has been approved of at the recent half-yearly meeting, held 7th October ult. The opening of the line throughout, from Detroit to the edge of Lake Michigan, was accomplished on the 6th September last. The loan of a further sum of £100,000 was sanctioned, to provide rolling stock and other matters required to put the Milwaukie line into good working condition.

The Grand Trunk (Canada) Company's Branch, between Sarnia and Stratford, is being completed. The works are let, and are being prosecuted with vigour. Length of entire (Grand Trunk) line (when completed) 1,114 miles, at estimated cost of £9,426,200.

The New Brunswick and Canada Railway and Land Company is about commencing active operations. Delegates of high official (local) standing from Canada and Nova Scotia are shortly to confer, in London, with Sir Bulwer Lytton on the railway scheme for connecting the British North American Provinces through British territory. The Company have just received a deed of grant for 30,000 acres of land, and will shortly, it is stated, open 65 miles of the line.

Grand Trunk of Canada.—The section from Stratford to London (31 miles) was opened for traffic on the 27th September ult., thus connecting Western Canada with Toronto and the East. The Grand Trunk system extends railway transit throughout the whole province of Canada. The mileage of the different sections is as follows:—Riviere du Loup to Chaudiere Junction, 100 miles; Point Levi to Richmond, 96; Arthabaska and Three Rivers, 30; Montreal to Toronto, 333; Toronto to Sarnia, 168; St. Mary's to London, 22; Victoria Bridge and approaches, 6; Montreal and Island Pond section, 143; Island Pond and Portland, 149: total miles, 1,057. It is a single line throughout, of the 5 ft. 6 in. gauge; but land has been secured for a double track, and many of the foundations and the masonry of the abutments have been put in for a double line. At the close of 1859, the Grand Trunk system will be a continuous railway from Detroit to Portland and Riviere du Loup, upwards of 100 miles below Quebec. Total cost, about £10,700,000, or £10,000 per mile, including the Victoria Bridge. By the Detroit extension the total mileage will be increased to 1,114 miles. Bridges, stations, and structures, of masonry and wrought iron, wooden erections being the exception, instead of the rule. It is destined to be the highway from the Ocean to the West, and *vice versâ*.

Recife and Sao Francisco-Pernambuco Railway [Brazils].—The directors at home, and the representatives of this Company in the Brazils, have brought the question of guarantee by the Imperial Government to a satisfactory conclusion. The guarantee is to commence from the day on which the line is opened. The claim of the contractor for alleged extras, including iron sleepers, sidings, and the fitting up of the stations, has been amicably arranged, the Company, on their part, having relinquished their claim against the contractor for loss of interest consequent upon the non-fulfilment of the contract in the time stipulated for. Recently a flood has come down, which has occasioned some damage to the ballasting at one of the embankments; the traffic, however, had only been stopped for a single day. In the opinion (official) of Mr. Vignolles, the engineer of the Bahia Railway, though the works were not finished in the way they might have been in this country, where skilled labour was obtainable, they were entirely satisfactory as regarded their solidity. On the first section of the line 17,000 passengers have been carried (two trains running daily) without a single accident to life or limb, and without delay "to speak of." The staff is now almost entirely composed of natives, there being only about two Englishmen employed as engineers, and one or two as firemen—the directors "thinking it more advisable to train up a staff of natives to work the line." The railway is stated to be highly popular in the Brazils.

Bahia and San Francisco.—The plans of the first section (8 miles) of this line have been completed and handed over to the contractor. A landing-stage has been raised for unloading materials from England, and temporary roads, &c., constructed. The 5,000 shares reserved for Brazil have been taken up, and the deposit paid. Both the Imperial and Provincial Governments have afforded the Company every facility.

Suez Railway [Egypt].—A letter from Alexandria states, that the Suez Railway is about to advance another step towards completion. The line will shortly be in operation to within 10 miles of the Red Sea. The heavier portion of the works is now completed, the 10 miles that still remain to be traversed being over a level plain.

Honduras [Central America] Interoceanic Railroad.—By late advices it appears that the hope of realising this project is abandoned by the inhabitants, who are projecting a waggon-road in its place.

Fatal Railway Collision on the Eastern Counties Railway.—On the night of the 9th October ult., a goods train, travelling at the rate of about 30 miles an hour, ran into a special train of empty horse-boxes at the Six-mile Bottom Station, on the Cambridge and Newmarket Railway. A composite first and second class carriage, and the brake-van of the first train, were smashed to pieces, and the under-guard of the goods-train killed.

The Vale of Clwyd Railway (line commencing by a junction with the Chester and Holyhead at Rhye, and terminating at Denbigh, length about 11 miles) was opened on the 14th October ult. with the customary rejoicings.

Collision near Chester.—On the 15th October ult. an alarming, but, happily, not fatal, collision occurred on the Birkenhead, Lancashire, and Cheshire Junction Railway, near Chester. An express train ran into a light, or detached, engine: by the shock 14 of the passengers in the express train were more or less injured.

Great Russian Railway (St. Petersburgh and Moscow).—A somewhat curious incident is spoken of in connection with this section of the monster railway. Since its construction, the actual length of railway between St. Petersburgh and Moscow has been found to be no less than 81½ wersts (about 60 miles) shorter than its nominal length of 607 wersts; or, in other words, that the Government, for whose account the railroad was constructed, has had to pay about one-seventh of the true value, or 12,000,000 of roubles more than it ought to have paid. As the rolling stock and working on this line are paid for at so much per werst (under a special contract), it follows that on this ground also the Government have been paying hitherto a fearful overcharge. The contractors for the line were an American company, and it appears that the discovery of the *miscalculation* (!) has been due to certain astronomical observations for determining the true distance between the two points, entrusted to Professor Struve.

The Innspruck Railway, it is reported, will be opened on the 5th Nov., 1858.

TELEGRAPH ENGINEERING, &c.

Turkish Telegraph Lines (Smyrna to Aidin), 62 miles.—The stores for the construction of the electric telegraph throughout this line have been delivered, and a telegraphic communication with the (section) station at Ephesus is to be at once established.

Black Sea (Government) Telegraphs.—The cable laid between Varna and the Crimea was simply a single copper wire insulated by gutta percha, the terminal at both ends being protected by galvanized iron wire, while that connecting Varna with Constantinople was from end to end covered with galvanized iron wire. The manipulating power of the two cables respectively, as indicated by Morse's instruments, was as thirty-two to fifteen words per minute, being seventeen words in favour of the former, evidently showing that the thin wire was approaching to the correct principle. The thin cable, however, lasted but seven months, owing (as Major Charles Oldershaw, late Director of British Telegraphs at Varna, surmises) to its being connected with heavy wire, which, offering an unequal resistance to the friction of the waves, broke at the junction of the strong and light cables.

Buoyant Cables for Deep Sea Lines.—Major Oldershaw, Royal Artillery, has proposed (and subsequently patented) a deep-sea telegraph cable, thus constructed—" One or more conducting wires, covered with gutta percha or vulcanized india-rubber, then a layer of compressed cork, bound round with hemp properly prepared with a protecting solution. The proportions of these materials such as to render the cable *sufficiently buoyant* to remain at a constant depth of between 100 ft. and 200 ft. below the surface, bringing it thoroughly under control. The ends of the cable on each shore to be covered with ' an iron tubular duct,' of sufficient length to protect it from the shore wave, and the chafing effects of the coast current." Alleged advantages: comparative cheapness of con-

struction—buoyancy such as to require no paying-out apparatus—one vessel might lay two lines at the same time—no liability to leakage, &c.

Steam v. Horses—Traction-Engines.—The Lords of the Admiralty, desirous of testing the practicability and economy of employing steam-power in place of horses, in the Government dockyards, have entered into an arrangement with Mr. Bray for the use of his steam traction-engine. The contract is to pay at the rate of £50 per month for the exclusive service of the engine to be employed in Woolwich Dockyard, for one month certain, experimentally, in the removal of timber and other heavy stores, hitherto performed by horses. On the 13th of October ult., the engine steamed into the dockyard, and carried out the allotted day's work with perfect steadiness, passing the windings and acute turnings, and discharging its load at the western extremity of the yard with ease and success. The amount of fuel consumed during the day was 6 cwt., at a cost of 3s. 6d.

Atlantic Telegraph Cable.—But little authentic information has transpired during the past month respecting the defective state of the great cable, beyond the report recently addressed to the Chairman and Directors of the Company by Mr. Henley, electric engineer:—1st. That the insulation is very seriously impaired. 2. That he has tested the cable by connecting one pole of a voltaic battery to the end of the cable with a galvanometer in circuit, and the other battery-pole to the earth. He finds a resistance to the current equal to very nearly 300 miles of the copper wire: in fact, to 290 miles altogether. By "resistance," he explains, is meant the impeding force more or less always encountered by electricity in its passage through various conductors. That in addition to this natural and inevitable resistance in every conductor, even when perfectly insulated, there is, in the present remarkable instance, "the resistance presented to the passage of the electric current by the "fault" itself, now that the insulation of the conductor has been seriously impaired, this fault perpetually reverting to its original condition; for on reversing the direction of the current, hydrogen is evolved; which hydrogen, by reducing the oxide and cleansing the wire, brings the fault back to its former state. Further, Mr. Henley is of decided opinion that "the fault is not beyond 300 miles." On the 20th October, Mr. Saward, the secretary to the Atlantic Telegraph Company, announced the receipt of a telegram transmitted through the defective cable from Newfoundland to Mr. Bartholomew, the company's superintendent at Valentia. The words were—"Daniell's battery now in circuit." In compliance with his request, instructions were immediately forwarded to Mr. Bartholomew, authorising him to use the company's Daniell's battery at Valentia.

The Submarine Telegraph Company have issued proposals to lay down a cable from Hull to Emden in Hanover, and another from Hull to Tonning in Denmark, under concessions which have been obtained from the respective Governments.

A Siberian Telegraph is announced in the *Invalide Russe*—namely, to unite Europe with America, by means of an electric telegraph across the Russian possessions in Siberia and America. From Portland, at the mouth of the Columbia, in the Pacific, to Moscow is only 2,000 miles (in America the lines of telegraph extend to 7,000). The telegraph line from St. Petersburg to Moscow will be extended to Kiachta, by which means news might be received from Pekin in a week. Should this be done, all nations who have intercourse with China will be forced (so, at least, says the *Invalide Russe*) to have recourse to this line, as being the shortest means of communication.

Submarine Cable between England and Holland.—The cable consists of 4 copper wires, coated with gutta-percha, and covered with 10 wires, size No. 00, thus making a cable 5 in. in circumference, and 5-8ths in. in diameter, weighing 8 tons 12 cwt. to the mile. On 18th September ult. the *William Cory*, iron screw steamer of 918 tons, left Greenwich, having on board 150 miles of the cable. Immersion commenced at Zanvoort, on the Dutch coast. On the afternoon of the 21st the end of the cable was landed, by means of a couple of lighters; and at 2 o'clock on the following morning steam was got up, and the paying out of the cable began. The apparatus consisted of 2 large drums on the quarter-deck, assisted by a jockey-wheel in front, and further aided by a bobbin or round wheel fixed over the hatchway to run the cable out of the hold. The cable was thus paid out at the rate of from 4 to 6 miles per hour—with the wind blowing hard and a heavy sea. Arrived at Dunwich, 23rd September, about 6 a.m.; 140 miles of cable successfully laid in 40 hours, it having been expected to occupy from 10 to 14 days. Soundings (taken during the whole of the operations) never exceeded 30 fathoms. Telegraph test, applied every 10 minutes, uniformly answered the instrument with correctness. Assuming these data to be authentic, we may congratulate the Submarine Telegraph Company on a complete and, as regards the simplicity of the submerging apparatus, inexpensive success.

Telegrams.—On the lines of the three principal telegraph companies, the number of telegrams transmitted increased from 1,017,529, in 1855, to 1,241,163, in 1857. The "mileage" increased from 43,720 miles, in 1855, to 46,482 miles in 1857.

MARINE STEAM ENGINEERING, SHIPBUILDING, &c.

Steam-Ships now Building.—At the Thames Ironworks and Shipbuilding Company, the *Orinoco* and *Magdalena* steam-ships, each of 3,096 tons, for the Royal West India Mail Company. The steam-ship *Nepail*, of 1,000 tons, for the Peninsular and Oriental Company.

War Steamers now Building.—From the official "Navy List" just published it appears, that there are now twelve screw steam-ships, five sloops, four frigates, three corvettes, three sailing ships, and one schooner, building at the various naval dockyards; carrying in all, 1,599 guns.

Wreck of a Screw Steamer.—The *Admiral Miaulis*, of 1,200 tons, belonging to the Greek and Oriental Steam Company, on her first voyage, has been lost on the Island of Oessel, near the Gulf of Riga. She was launched lately from the building yard of Messrs. J. Pile and Co., West Hartlepool, and was on her voyage from Cardiff and Havre for Cronstadt, having on board three state railway carriages for the Emperor of Russia, to open some of the new railways. Insured (ship and freight) for £30,000, nearly total loss.

Steam-Transports for India.—The Lords of the Admiralty have inspected the model (submitted to them by Mr. Peter Rolt and Captain Ford, O. N.) of a first-class iron screw-steamer, of 5,000 tons, with engines of 1,000 nominal H.P., designed for conveying to India, in forty-one days, 2,000 troops, with their officers, horses, artillery, baggage, &c.

Burning of the Screw Steam-ship "Austria" at Sea.—The *P. Pemberton*, of Virginia, arrived (3rd October ult.) at Bristol, reporting the destruction by fire, on the 13th September ult., of the *Austria*, a fine screw steam-ship of 2,500 tons and 600 H.P., built last year, at Greenock, for the Hamburg and American Company; commanded by Captain Heydtman. Left Southampton on the 4th, for New York, with 513 souls on board, crew and passengers, 18 of whom had been rescued by the *Lotus*, bound for Halifax, and 50 others by a French barque. The remainder of the passengers perished. Captain Heydtman jumped or fell overboard, and was drowned. The fire was caused by fumigating the ship between decks with boiling tar.

The Monster Floating Derrick, recently launched, and now moored off Blackwall Pier, was (1st October ult.) officially visited by the Lords of the Admiralty, and inspected by them.

The Russian Steam-Frigate General Admiral, for a year past in course of construction at the yard of Mr. W. H. Webb, of New York, was launched there on the 21st September ult. She is to take in her machinery and be ready to sail from New York about the 1st of May next.

Steamer Launches.—At Deptford Royal Victoria Dockyard, 22nd October ult., H.M. screw steam-sloop *Icarus*, 11 guns, engines 150 horse-power. Ordered to Woolwich to receive her boilers and screw-machinery. Engines manufactured by Messrs. Rennie, of Blackfriars.

The launch of the steam-ship *Weser*, 3,200 tons burthen, built for the North German Lloyds took place 21st October ult., from the iron ship-building yard of Messrs. Palmer and Co., at Jarrow-on-Tyne. A somewhat novel feature in this case is, that the *Weser* was launched fully rigged, and with her engines in and ready for sea, being the first vessel ever launched in that complete manner—at all events, on the Tyne. She is intended for the emigrant trade between Bremen and New York.

The *Donegal* screw steam-ship, 101 guns, was launched at Devonport, 23rd September ult. Dimensions—length from figure-head to taffrail, 274 ft. 9 in.; ditto between perpendiculars, 240 ft.; ditto of keel for tonnage, 204 ft. 9¾ in.; breadth, extreme, 55 ft. 5 in.; ditto for tonnage, 54 ft. 7 in.; ditto moulded, 53 ft. 9 in.; depth in hold, 24 ft. 5 in.; burthen in tons, old measurement, 3,245 35-94; ditto, new, 2,954 920-3500; engines, 800 H.P., by Messrs. Penn and Co.

From England to America in Six Days.—The most rapid transatlantic passage ever yet performed has been that of the steam-ship *Pacific*, one of the Lever liners, which arrived (1st October ult.) at Galway from New York, *viâ* St. John's, Newfoundland, in six days and one hour from the latter port, bringing dates up to the 24th of September from New York, by electric telegraph to St. John's. The Atlantic Royal Mail Steam Navigation Company have subsequently announced that arrangements are now in progress, by means of which they will be enabled to insure to the public, communication between London and New York in *six days*.

The "St. Jean d'Acre," 101 screw two-decker, having been fitted, at Devonport, for the first-class steam reserve, went out of harbour on 30th September ult., and took a trip into the offing to test her machinery and speed.

Water-tight Compartments.—The practical advantages of this recent improvement in the system of shipbuilding are apparent from the following extract from the log of the *North American*, Royal Mail screw steamer, which arrived, after imminent danger of foundering, from New York, at Liverpool, 7th October ult.:—"28th Sept., 1·30 p.m., Outer Islet, bearing N.E. by N. half N., distant about 4', struck on a sunken rock, causing ship to shake and vibrate very much, almost stopping her, when she careened over suddenly to starboard and slipped off; stopped the engines immediately; sounded 11 to 12 fathoms close to; carpenter sounding the wells found the holds all tight, *with the exception of the fore compartment*, which instantly filled to the level of the water outside. 1·40, turned a-head and proceeded."

Launch of a Monster Floating Derrick.—A novel and huge kind of vessel, or floating crane, the first which has been constructed in this country, was launched at the Thames Iron Shipbuilding Works at Blackwall. The hull is a kind of diamond shape; she is entirely constructed of iron, as also her masts or booms. She is flat-bottomed, and a bulkhead runs fore and aft through her whole length, so that when she is in operation (raising a sunken vessel), one-half of her will be so gradually filled with water as to counterbalance the weight hanging to her boom on the other side. Hull braced with iron beams, and her boom supported by iron legs. Tonnage, 5,000; length over all, 257 ft.; breadth, 90 ft. (8 ft. more than the *Great Eastern*); depth, 14 ft. Intended for raising wrecks, stranded and sunken vessels, &c., on the coasts of the United Kingdom; the principle having been successfully tried in America, where upwards of 400 sunken vessels, amongst them the *Ericson*, of 2,200 tons, sunk off New Jersey, with her caloric machinery on board, have been raised on this principle; henceforward to be known as the "Patent Floating Derrick."

Steel Steamers for the Ganges.—Messrs. R. Stephenson and Co. have in hand six boats for the navigation of the Ganges. They are to be built entirely of steel, and fitted with engines of 170 H.P. Draft, 2 ft. water when light, and 4 ft. with the heaviest load.

Life-Boats.—The National Life-Boat Institution has, since its first establishment, expended upwards of £25,000 on life-boats and their appurtenances, and has voted 79 gold medallions and 603 silver medals for distinguished services in saving life, besides pecuniary rewards amounting together to £10,699. Total number of persons saved by its means from shipwreck, 10,475.

Brighton New Life-boat.—On the 6th of October ult., advantage was taken of the stormy and tempestuous state of the weather, and the heavy sea which prevailed, to test the qualifications of the Royal National Institution life-boat (30 ft. and carriage) recently stationed at Brighton. At half-past three in the afternoon, the crew having been got together, she was launched from her arch in the usual beach-mode method, by houghs, and got off in admirable style by means of her haul-off rope, which is always out in readiness for an emergency; each man with his cork life-jacket on; and on the word being given, they rowed to the windward, the boat riding over the surf in perfect obedience to the crew. She was then rowed twice over the outer bar, where the heaviest swell was, let drift broadside under the sea, when she filled several times, but discharged as fast as the water came in. After about an hour's trial she returned to the shore, amidst the cheers of the spectators, who lined the beach and cliffs. She is on Mr. Peake's plan, and was built by the Messrs. Forrestt.

New [Institution] Life-boats have been completed, and are about to be dispatched to the following stations, namely—A first-class 32 ft. boat to Barton; one first-class 34 ft. to Cromer, on the coast of Norfolk; one second-class 30 ft. to Kilmore, on the Scotch coast; one ditto to Cawnsor, in Ireland; and one first-class 30 ft. to Waselburg, in Scotland; with a second-class 30 ft. boat to Calais, as a present from the Government to the port-officials of that city.

The Prussian Government have registered a first-class life-boat for the port of Nausahrwasser, near Dantzic. Construction to be superintended by Mr. Peake, assistant master shipwright at Woolwich Dockyard. Cost £160.

Transatlantic Steam Packet Station [Ireland].—As a rival to the hitherto successful "Lever Line," an attempt, supported by the Waterford and Limerick Railway directors, &c., is being made to substitute Foynes for Galway as the station for running steamers between Ireland and America. A company, with this object in view, has been started under the auspices of the Corporation of Limerick.

Steam [Mail] Packets between Spain, Cuba, and Porto Rico.—The Spanish Government have decreed the establishment of a line of steamers for this service. The terms of contract (to be decided in February, 1859, foreign tenders being receivable) include a condition to perform the passage between Cadiz and the Havannah in steam-packets every fifteen days. The contractors to be bound to have eight steam-packets for the service; to sail under the Spanish flag; to be new ships; the hull of iron, and to be constructed of the best materials; each to measure 2,300 tons; to be either constructed in England, or after the English model of fast-sailing steam-packets; four to be ready for sea on the 13th January, 1860. Company authorised to construct steam-packets measuring 3,500 tons. Boats are to touch at Santa Cruz, Teneriffe, and Porto Rico; but never for more than twelve hours. Contract to be made for eight years; and company to give security to the amount of 4,000,000 reals (£40,000).

The African Steam-Ship Company have entered into a new contract with the Admiralty for the conveyance of the West African mails. Liverpool is to be the port of departure and arrival; Goree omitted as a place of call; Cape Palwas substituted for Monrovia, and the three principal mouths of the Niger (the Benin, the Nun, and the Brass) are to be visited. The contract is for seven years, and the payment £30,000 per annum. The steamers will call at fifteen ports, rivers, and places, between Madeira and Cameroons.

The affairs of the North Lincolnshire Shipbuilding Company are now before the Bankruptcy Court on petition for a winding-up order, to be heard on the 23rd October.

The "Ceylon" Trial Trip.—At Southampton, 16th October ult., official trial was made of the new screw-ship built for the Peninsular and Oriental Company, by

Samuda Brothers, of London. Amongst the party on board were the Admiralty Local Superintendent of Mail Packets, two Admiralty Surveyors, two Surveyors to the Board of Trade, &c., &c. The dimensions of the ship are as under—

	ft.	in.
Length over all	320	0
Ditto between perpendiculars	295	0
Beam	40	11¾
Depth of hold	26	4

She ran the measured test-mile six times, having only three boilers in use during the first and second runs, and all four during the remainder of the trials, the results of which were as follows:—

	Time. m. s.	Knots per hour.	Revolutions.	Pressure of steam.
1st	4·55	12·203	55	12 lbs.
2nd	5 23	11,145	53	10 ,,
3rd	4·18	13·953	62½	20 ,,
4th	4·42	12·766	61½	20 ,,
5th	4·22	13·740	61	20 ,,
6th	4·39	12·903	61·6	20 ,,

Being an average run, taking the mean of the last four runs, of 13·940 knots per hour. Draught of water, 18 ft. forward, and 18 ft. 6 in. aft. Registered tonnage 7,374 8-100ths, and 2,373 4-94ths builders' measurement. Engine, 450 nominal horse-power: but worked up to an aggregate power of 2,054 horses during the trial. Direct-acting, on Humphry's and Tennent's principle; actual area of their base, 8 ft. thwartship by 16 ft. 4½ in.

Steam Fire-damper for Ships.—The whole of the Peninsular and Oriental Company's ships (including the new screw-ship *Ceylon*), are fitted with a very simple apparatus for the suppression of fire, should such a calamity occur on board. It consists of a series of pipes, extending all over the ship, attached to a steam-cock at the bottom of the boiler; so that, by turning this cock, on the outbreak of fire in any part of the vessel, a perfect deluge of steam is poured upon the flames. The first vessel fitted with the apparatus (the invention of which is ascribed to Mr. A. Lamburg, the Company's resident engineer) was the *Jupiter*, sold many years ago to the North of Europe Steam Navigation Company.

The "Agamemnon," 91, screw, is to be supplied with new boilers at Portsmouth.

MILITARY ENGINEERING, &c.

Iron Guns.—A batch of six iron guns, cast in the Royal Standard Foundry in Woolwich Arsenal, were (2nd October ult.) submitted to the ordinary proof, when four of the number burst into fragments. Since the first casts were made in last February, the failures at this costly establishment have been at least 10 per cent. in guns which have been broken in process of turning, and others which have burst at proof.

New Platform for Heavy Ordnance.—A series of experiments have recently been carried out at Shoeburyness, in presence of the Select Committee of Royal Artillery officers, for testing a newly-invented platform for heavy ordnance. The result is stated to be satisfactory.

The New Defence Works at Fort Matilda, on the Clyde, are completed. They are of a very formidable nature. The guns, eight 68-pounders, are to be placed *en barbette*, and will sweep the Clyde from Kempock Point to the tail of the bank. The barracks are situated on the south side of the fort, and are loopholed for musketry on all sides. The works have been completed under the superintendence of Major Fitzroy Somerset.

A New Camp is to be formed at Woolmer Forest, Sussex, about 6 miles from Petersfield. The report of the Company of Sappers and Miners ordered to survey the spot with a view to the encampment, has been sent into the War Office. The site is reported as being admirably suited for the purpose. The land occupiers have received notice to vacate, and a large body of troops will be assembled there early in the spring.

Royal Standard Gun Foundry, Woolwich.—The outlay for this establishment, as appears by the estimates for building, machinery, &c., since the 1st January, 1854, to 31st March, 1856, has been upwards of £130,000.

Mortar Practice, &c.—Woolwich, October 4th ult.—M. Etienne Oussof, Lieutenant de la Garde de Sa Majestie l'Empereur de Russie, was present at the mortar firing. The flight of the shells, although over a range of 800 yards, was directed with much accuracy, some of them alighting within 6 yards of the flagstaff. He was afterwards accompanied by a portion of the garrison staff to witness some gun-practice by one of the field batteries of the Royal Artillery.

New Cartridge.—Provisional protection has recently been granted for a new species of cartridge, the invention of Mr. George Redford, late acting Assistant-Surgeon of the 58th Regiment. The novelty consists in the making of bullets and cartridges for the Enfield rifle, out of the same piece of metal, and at the same moment. The cartridge is a prolongation of the bullet into a very thin sheath, which can be charged, folded, and secured. The metal cartridge sheath breaks readily away from the bullet. The alleged advantages of the new cartridge over the old system are—cheap and rapid production, and (one great advantage, if practicable, for naval purposes and for transport of ammunition by sea) that when charged and folded up, bullet and cartridge may be thrown into water, and yet sustain no injury.

Steam Rams.—Mr. James Nasmyth, as one of the original suggestors of the new (proposed) plan of naval warfare, "finding that the steam-ram system is actually being carried out by another Power," has published an appeal to the Government, urging upon them to test without delay its efficiency by having a few thousand pounds expended in the construction of one of these vessels, and a run with it at the hulk of a discarded three-decker."

Rifled Cannon.—The question, at last, seems to have been seriously taken up by the military authorities. During some experiments recently instituted at Portsmouth, to test the capacity of wrought-iron sheets to resist the power of ordinary cannon shot at sea, it had been found that a wrought iron panel on a ship's side would resist the fire of heavy guns for hours together, thus apparently establishing the newly broached principle of iron-sided vessels of war. It occurred, however, to one of the parties present to try the efficacy of an old Government gun, rifled by Mr. Whitworth. The result was declared in an instant—for the new cannon is stated to have "slapped her shot" through the iron-plate that had baffled the powers of ordinary artillery, "as if it had been so much gingerbread"—thus, it is argued, proving the superiority of rifled over the ordinary artillery. The question, at all events, is of importance enough to demand a strict and impartial inquiry.

GAS ENGINEERING—(HOME AND FOREIGN).

Deaths from Escape of Gas.—A man and his three children were suffocated by an escape of gas, which took place (15th October last) in their cottage, in a wretched row of buildings at the back of Church-street, Pillgwenlly, near Newport, Monmouthshire.

Gas Retorts, Coke Ovens, &c.—Dr. Southwood Smith found that the workmen in the Gas-works employed in making up the fires and other occupations which subjected them to great heat, lost on an average (by perspiration) 3 lbs. 6 oz. of fluid in 45 minutes; and when working for 70 minutes, in an unusually hot place, their loss was 5 lbs. 2 oz. and 4 lbs. 14 oz.

WATER SUPPLY—(METROPOLITAN AND PROVINCIAL).

Ostend Artesian Well.—The townspeople of Ostend are having an artesian well sunk, in the hope that available water may emerge from under the German Ocean. The work has hitherto proceeded steadily, but, by late accounts, the shaft having been sunk as low as 422 metres, the boring machinery cannot be got to work efficiently.

Public Drinking Fountains have lately been placed at Chester, in different parts of the town, at the expense of Mr. Peter Eaton, an extensive brewer, and late mayor of that City. A neat bowl is attached to each fountain for the convenience of drinking.

In Glasgow, the City Water Commissioners have agreed to the erection of no less than thirty-two ornamental fountains, being two for each ward of the city, in the most public thoroughfares, the cost to be defrayed by subscription undertaken by the Temperance Societies.

In Aberdeen, twelve fountains have been erected for the public use, one of them being a fountain "head," of the human form, the water flowing out of the mouth into a 20-gallon trough, while behind the pillar to which the head is affixed are two washhand basins for public use, which cleanse themselves in the course of a single minute.

At Southport, and in the Market Place at Worcester, public fountains are likewise in course of erection. At the former place the authorities of the town have accepted the offer of Mr. Henry Clark, of Larkhill, to present them (on the terms of the Commissioners supplying the water) with three polished marble fountains, one to be placed near the Lancashire and Yorkshire Railway, while at the latter a benevolent individual supplies a fountain of elegant design (the figure of a swan), in the centre of a basin 7 ft. in diameter, and 7 ft. 6 in. high, to be executed in iron bronze, the fountain issuing from the swan's bill.

The Directors of some of the railways have resolved to erect drinking fountains at each of their respective stations.

Artesian Well at New Swindon.—The works are progressing satisfactorily. The excavation and walling up have now been carried to a depth of upwards of 92 ft. Even now there is a constant supply of about 25,000 gallons every twenty-four hours.

HARBOURS, DOCKS, CANALS, &c.

Birkenhead Docks.—The Mersey Dock Board, at their meeting (30th September ult.), accepted the tender of Mr. W. M'Cormick for the excavation of the low-water basin at Birkenhead, the enlargement of the Morpeth Dock, &c., including the filling-in and formation of a quantity of land which is to form wharves, quays, yards, streets, &c.

Chatham Stone-docks.—The first of the new large stone-docks which the former Board of Admiralty directed to be built at Chatham, has been completed, having occupied about three years in its formation. It is nearly 400 ft. in length, 93 ft. in width, and 40 ft. deep. Foundation on beds of concrete, several feet deep: the dock entirely of the best Scotch granite, of which several million cubic feet have been used. The new basin is to be opened forthwith.

Southampton Docks.—The total number of passengers (from foreign countries) landed in Southampton Docks, for the three months ending 30th September, amounted to 9,605.

Harbours of Refuge [Ireland].—The localities on the northern coast, competing for preference with the Royal Commissioners, now on their tour of examination, as regards the construction of a safety-harbour on some part of the Northern (Irish) Coast are—1st, Skerries; application patronised by the Municipal Body and Harbour Commissioners of Drogheda, and backed by the Dublin Chamber of Commerce—2nd Carlingford, 3rd Portruth, 4th Clogher Head; the latter, however, is believed to be out of the race. On the Southern Coast the choice, it is surmised, will be between Waterford and Wexford on the south-east.

Canals *v.* Railways [France].—The inland navigation (*navigation intericure*) interest in France—threatened, it would appear, with utter extinction, from the rapid extension of railroads, and the alleged unjustifiable conduct of the latter on the score of differential traffic-charges—has ventured on a decided step in self-defence. In several of the departments a petition to the Emperor is in course of signature, praying for the abolition of all Government dues and charges on inland navigation; and 2nd, That in the event of the system of differential transit or tariff charges not being in all cases absolutely abolished, goods for transit by inland navigation, whether as regards the distances they may have to pass over on railways, or from thence by water carriage to their place of destination, or from their starting-point to arrive at their place of embarkation for water-carriage, shall only be liable to tariffs proportional to those they would be subjected to for passing over the whole distance on railways. One subject of complaint is, that the railway companies have systematically established low rates of carriage on all their respective lines running abreast of water conveyance, raising them, however, considerably wherever they find themselves safe from competition; for instance, coal passing from Saint Etienne to the water-carriage station pays ten centimes per ton, whilst they are charged but four centimes if they are sent straight through to their destination, if there exist concurrent means of transit by water-carriage.

Goderich Harbour [Canada].—The Buffalo and Lake Huron Railway Company are in treaty for the purchase and improvement of this harbour, with the intention of carrying their present terminus down to the water's edge, access to the Lake traffic appearing indispensable for the railway. At present, one steamer calls twice a week, and then only with passengers.

Harbours of Refuge.—Symptoms of uneasiness in regard to the (alleged) extravagant expenditure on the great harbours now in progress are beginning to manifest themselves in various quarters, including Liverpool itself, the great emporium of the mercantile shipping interest, where the proceedings of the Commissioners are watched with evident misgiving, and opinions are advanced advocating the propriety of improving existing ports, rather than of erecting new works at an enormous cost. The Government estimate for Alderney alone is £1,300,000, of which sum £650,000 has been already expended; and Captain Claxton, in his evidence before the Select Committee last year, said the money at Alderney had been totally thrown away; "that nobody went there, and nobody knew anything about it, except the Lords of the Admiralty: there was not room for seven ships without bumping against each other." Sir Charles Napier stated in the House that it was of no use, either as a harbour of refuge or for defence. The original estimate for Dover was £650,000, but it is calculated that the cost will be near £6,000,000, and the work will, in all probability, not be finished in the present, or even the next, generation. A ship-captain assured the Commissioners that "more vessels had been lost running for harbours of refuge, than had ever been lost putting out to sea;" and the statistics of the loss of lives and vessels that *might have been* saved by such harbours are regarded by many as illusive. Since 1851 the vast sum of £2,315,788 has been voted for harbours of refuge; and the estimates, given in the report of Mr. Wilson's recent committee, amount in the aggregate to £2,825,000. In the presence of such astounding figures, no wonder the subject is beginning to attract the serious attention of the public.

The New Gate to the London Docks.—On the 15th October ult., to accommodate the numerous arrivals of shipping, chiefly from the West Indies, the London Dock Company commenced to dock vessels at their new entrance, as yet scarcely completed. The gate-sills next the river are laid to give 28 ft. depth of water, by Trinity datum. The entrance is 60 ft. wide, with two locks, one 200 ft., the other 150 ft. long, capable of being used as one lock of 350 ft. The gates and bridges are opened and closed with great ease and rapidity, by means of hydraulic machines. The entrance affords the means of admitting or passing out vessels of the largest class at any period of the tide, when there is in the river sufficient depth of water for them. By the proposed new arrangements for docking vessels at one entrance, and undocking them at another, detention and risk will be avoided, and ships bound outwards will save much time. The new basin is excavated so as to give 4 ft. more depth of water; and this additional dock accommodation is to be surrounded by

extensive warehouses and sheds for merchandise. The new dock and works are in close proximity with the Shadwell Station, so as to be easily reached by the Blackwall Railway.

NEW DOCKS AT THE MOUTH OF THE AVON, and in connection with the Bristol and South Wales Union Railway (recently commenced), are in contemplation; and in the event of their construction as proposed, it is resolved to extend the line from Aust to Shirehampton.

NEW DOCKS AND BASIN AT PORTSMOUTH.—The Admiralty have resolved that the piece of mud land on the side of the Hard, at Portsmouth, shall be reclaimed, and a steamer basin and a steam factory formed on the spot. The new basin will have an area of from 50 to 60 acres, communicating with that now in use, with building or repairing docks 500 ft. in length, space for additional factory buildings, seamen's barracks, &c., arranged so as not to interfere with the present channels of the harbour.

THE SUEZ CANAL.—This undertaking, the feasibility of which has created so much angry discussion between English and Continental engineers, appears now to be in a fair way of being practically carried out. The required £8,000,000 sterling for estimated expenses has been already subscribed for by the various European States, with the exception of £1,600,000, which has been reserved for England, in the event of her capitalists seeing sufficiently good reasons for modifying their recently-expressed hostility to the scheme. In the list of subscribers the reigning Viceroy of Egypt figures for £1,280,000; France, £1,600,000; Turkey, Egypt, and Syria, £840,000; Austria, and the Lombardo-Venetian State, £800,000; Russia, £480,000; Northern Germany, Sweden, Denmark, and the Hanseatic Towns, Prussia, Holland, Portugal, and some other minor states of Europe, £600,000; Spain, Portugal, Italy, and Greece, £400,000; whilst the United States of America furnish an equal sum. The canal is to be 92 miles in length, 26 ft. deep; for a distance of 12½ miles its width is to be 329 ft., and for the remainder of the distance 263 ft. At either extremity there will be two jetties constructed in order to form a commodious port. Those of Suez will be respectively 2,200 and 2,500 yards in length; those of Pelusium 2,700 and 3,800 yards.

FAILURE OF THE NORTH QUAY WALL, GLASGOW.—About 12 o'clock in the night of the 29th ult., a part of the quay-wall opposite Brown-street fell in. The wall of which the fallen part is a portion extends from the York-street Ferry to the Royalty Burn. It is 315 yards in length, and was completed in the year 1814 from the plans and specifications of the late Mr. Rennie. In 1833 a portion was renewed; and in 1842 two other portions required to be renewed, and the entire length supported by driving piles in front. The part now fallen is 212 ft. in length, and extends eastwards to the Crane seat, beyond which there are (as officially reported to the Lord Provost by Mr. Ure, engineer, charged with the survey of the town quays) such indications of failure (bulging of the wall, sinking of the causeway, and opening of its joints, &c.), as to render it unsafe and unfit for the mooring of any but light-drafted vessels opposite to it. The cope of the decayed part has moved forward 10½ ft., and sunk 4½ ft., and the toe has removed forward 3 ft., all at the point of greatest movement. The Committee (of the Clyde Navigation Trust) have recommended that Mr. Ure be instructed to take in estimates for rebuilding the portion of the north quay which has fallen in, and which would cost about £3,200.

GLASGOW STEAM-BOAT QUAYS.—At the monthly meeting of the Clyde Navigation Trustees (5th October ult.), Mr. Taylor said he had made a personal inspection of the quays lately, and was far from satisfied with their condition. "Even the place where the passengers go aboard the steamers was in a dangerous state, and he should not be surprised to hear some day soon that it had given way, and some hundreds pitched into the water. Something must be done, as, after the repeated warnings which had been given, the public would, doubtless, hold the Trust responsible for the consequences of delay." In this the other members appear to have concurred; but it was stated that the matter must lie over till the new Trustees were elected. Here the matter dropped.

BRIDGES.

THE NEW BASWICK (TRENT VALLEY) RAILWAY BRIDGE.—A temporary bridge, replacing that recently destroyed by fire, has been completed by Mr. Woodhouse, the resident engineer, in the short space of about three weeks. The interrupted through traffic on this line was resumed on the 14th October ult. The trains pass over the new structure at a slow speed. The old wooden bridge is to be replaced by an iron girder bridge, on stone piers.

BUFFALO BRIDGE, U.S.—A Bill has passed the New York Legislature, enabling the town of Buffalo to guarantee 6 per cent. in bonds for a fixed number of years, to be issued for the construction of a bridge across the Niagara, for which an Act had already been obtained. This is an international work of great interest, more especially to the local railways, both British and American, substituting as it does the advantage for traffic of a permanent bridge for the hitherto uncertain, though costly accommodation of a traffic by ferry, thus limiting the expense of transit to the amount of toll.

BOILER EXPLOSIONS.

AT MANCHESTER (West Gorton Cotton Mill), a boiler explosion occurred, 1st October ult., by which two men were killed. The engine was inside the shed, and the boiler outside. The workpeople, men and girls, were mostly at their looms, when the explosion took place, destroying engine, weaving-shed, and a chimney 45 ft. high. The two men were buried in the ruins of the engine-house, irrecoverably bruised and crushed. Boiler torn into fragments. Supposed cause—driver having got up steam with insufficient water, and subsequent admission of cold water upon the heated plates.

IN THE DOCKYARD OF TOULON a fearful boiler accident has occurred. The boiler of the corvette *Roland* was being tried. It burst with a terrific noise, wounding upwards of thirty-five persons, nine of whom have already died. Among the dead are Capt. Ducis, of the *Roland*, and the Chief Engineer. The Chief Engineer of the Arsenal was severely scalded.

AT GODLEY, near Hyde (20th October ult.), a boiler of 50 horse-power, in the cotton mill of Messrs. Randall, Hibbert, and Sons, burst, killing one of the workmen (the fireman), and damaging the building considerably. Cause assigned, insufficiency of water and consequent over-heating. The boiler-plate over one of the flues had been red hot, and had given way.

MINES, METALLURGY, &c.

A FEARFUL COLLIERY ACCIDENT, by fire, occurred (Sept. 30th ult.) at Page Bank Colliery, 2 miles distant from Spennymoor, and 6 miles west of Durham. At about eight o'clock a.m. the shaft of the pit was discovered to be on fire, and one of the overmen was killed by portions of the burning brattice. Eighty-five men and boys were in the pit and could not be got out. The fire had consumed all the brattice, and had extended to the coal in the return drift. At seven p.m. the fire was on the increase, and serious doubts were entertained as to possibility of rescuing those in the pit. On the 1st October seventy-six men and boys were rescued, ten being killed. On the 14th October the Coroner's Jury returned a verdict of "Accidental Death," annexing their opinion "that the brattice in the shaft was ignited by a spark, but from whence the spark came there was no possible evidence to show."

STONE QUARRYING.—FALL OF A CLIFF.—An alarming accident occurred (Sunday, 26th Sept. ult.) at Torquay. For some time past, extensive excavations have been going on at the back of some premises in Victoria-parade. Abutting against the sea end of the Cliff is a row of tenements, occupied by a number of poor families. At five o'clock a.m. a mass of rock and rubbish, about 200 tons in weight, fell from that side of the quarry with a tremendous crash, carrying with it a considerable portion of the wall and roof of one of the houses nearest the cliff. A young girl, one of the inmates, was buried beneath the *débris*, but by timely assistance was extricated comparatively unhurt, notwithstanding that several stones, each quite 40 lbs. in weight, were lying on her body. The stones, it is conjectured, must have first fallen on her bed, and then rolled upon her. Luckily, the accident occurred at a period when the quarrymen were not at work, otherwise the loss of life must have been fearful.

FATAL COLLIERY ACCIDENT.—In Monkwearmouth Colliery, a workman was in the west part of the pit, driving a horse with empty tubs. The horse, it is supposed, on being whipped, started from the rails against the props, which were 18 in. from the rails; that the horse had knocked out one of the props, and a "baulk" of timber, about 12 ft. by 1 ft. square, had fallen upon deceased, who had complained to one of the deputy-overmen of being hurt in the side—was taken home, where he died on the 29th September ult. Inquest held at Monkwearmouth, 1st October ult. Adjourned in accordance with the Government regulations.

AUSTRALIAN COPPER.—The Government returns of South Australian exportable produce, during the last ten years, give a total value of copper-ore of £2,769,504; agricultural being £2,712,166; and pastoral, £2,258,823. Thus showing the copper exports to be in advance of the latter.

FRAZER'S RIVER GOLD FIELDS, British Columbia.—The "Vancouver Island Gazette" of the 14th August ult. says of the New Caledonia gold mines, the river had fallen 2½ ft. at Fort Hope, and 4½ ft. at Fort Gale. 10,000 miners were at work, with good prospects, and all mines below Fort Hope were doing well. Sixty pounds of gold had been brought down to Victoria. Six men had taken about 600 dollars in six hours at Fort Hope by using a rocker only, and 3,000 men were then at work.

PRICE OF ENGLISH COPPER.—A reduction of £4 10s. per ton in the price of copper has been announced at Birmingham, making the present price of tough cakes and tile £98 per ton, for quantities of three tons and upwards. Manufactured copper is reduced in price one halfpenny per ton.

THE BALLARAT NUGGETS.—By late advices from Sydney, three nuggets of gold, of the aggregate value of £14,000, were being exhibited in Melbourne previous to being shipped to London. They were taken out in the Ballarat district, and are respectively named the "Welcome," the "Little Welcome," and the "Nil Desperandum." Of the first-named specimen of pure gold, far eclipsing the once celebrated "Blanche Barkly" nugget, we made mention in our last month's Notes and Novelties.

OF AUSTRALIAN GOLD there were shipped from January 1st to July 13th, 1858, 1,407,619 ozs.

QUARTZ CRUSHING.—The quantity of auriferous quartz crushed at Clunes (Port Philip and Colonial) during the month of July (five weeks) was 1,536 tons. Profit, £1,553.

MELBOURNE.—The quantity of gold melted at the assay office during the month of July last, was £33,848 ounces.

FATAL COLLIERY ACCIDENT—CHOKE-DAMP.—On the 13th October ult., about 8 a.m., near two hundred men were engaged in the extensive pit of the Primrose Colliery, worked by the Primrose Coal Company, situated near Pontardawe, Swansea Valley, about 9 miles from Swansea. An alarm was given that the fatal choke-damp was out. Fortunately it transpired that the catastrophe was limited to a distinct heading or working known as the "Old Machine Level," in which only thirty men were then engaged; of these, fourteen were brought up lifeless; seven horses were also stifled in the pit. There was no explosion of any kind, and the bodies, when brought up, are described as being undistorted, and having the appearance of sleep. The Government Inspector of Coal Mines for the South Wales District was on the spot a few hours after the accident, and inspected the pit, air-courses, &c., preparatory to the inquest.

RAILWAY CONSUMPTION OF IRON.—According to some recent German statistics on metallurgy, the quantity of wrought and cast iron consumed, in 1857, in Europe and America, in the construction of 117,500 kilomètres of railway, amounted (on an average of 80 kilogrammes per metre) to 9,400,000 tons. It is calculated that there is a loss of 133 grammes per kilomètre at every passage of the train; and, estimating at ten the number of trains in a day, this would give 133 grammes per metre and per day on 117,500 kilomètres, or 156,000 kilogrammes per day, equal to 56,000 tons per annum. Rust consumes an analogous quantity of iron. Thus every year 112,000 tons of iron return back into the earth in the shape of dust. In ten years, as the minimum, the rails and accessories must be renewed, which must necessarily entail a loss of 15 per cent. on the weight: say a total loss of 1,430,000 tons. Every ten years, therefore, there will be—

Loss by friction	1,120,000 tons.
Loss by renewal (re-working)	1,430,000 „
Total loss	2,550,000 tons.

To the above calculation must be added the iron which is the chief material in the rolling-stock, and the wear and tear of which may be reckoned at an equal figure. Basing an approximate calculation on the number of kilomètres in the year 1857, a supply of five millions of tons of iron is requisite every 10 years for the *keeping in repair* of the railways, or 500,000 tons per annum.

APPLIED CHEMISTRY, &c.

ALCOHOL FROM ASPHODEL ROOTS.—In a former number we alluded to a new process by MM. Felix and Gentil, of preparing alcohol from the roots of the tuberose plant Asphodel. The details of the process employed have recently been published, and may be thus shortly described. The tubers, cleared from the stalk, leaves, &c., are first cut into sections of from 8 to 10 centimetres cube; then dried in a stove, or, it may be, merely exposed in the sun till sufficiently dried. They are then macerated in four times their weight of water, acidulated with from 8 to 10 per cent. of sulphuric acid at 50°, if the tubers be perfectly fresh; or otherwise with from 2 to 7 per cent., according to circumstances, namely, of the richness in juice, and alcoholisable qualities of the tubers. For the sulphuric acid may be substituted the hydrocholic or any other acid proper for transforming the saccharine matters into "glucose." The macerated mass is then brought into ebullition for 4 hours by means of steam, left for 8 hours at rest, and the clear liquid drawn off; the tubers are subjected to a second maceration, but with only half the weight of water.

MUREXIDE, as a Dye for Woollen Goods, &c.—Hitherto the use of the new colouring matter "murexide" has, for various chemical reasons, been found practically applicable only to cotton and silk. M. Ferdinand Petersen has published a process whereby woollen stuffs may be dyed with it of an amaranthine tint, equally uniform and durable, even by the cold method. To obtain this result, all that is required is to divest the wool of its alkaline quality (*alcalinite*), and to render it, on the contrary, slightly acidulous.

SILICATE OF LIME as a Preservative for Stone, &c.—Ransome's patented process has the merit of being exceedingly simple. The stone to be treated is first cleaned from extraneous matter on the surface, and is then saturated with a solution of silicate of potash or soda, applied with a common brush, which readily finds its way into all the minute crevices and pores of the stone. This is followed by a solution of chloride of calcium (lime), applied in a similar manner. These two solutions mutually decompose each other upon coming in contact, and silicate of lime (a most indestructible substance) is produced in the structure of the stone, firmly agglutinating the various parts of it in an indissoluble bond. The resulting chloride of potassium or sodium, as the case may be, is easily removed by an excess of water.

PHOTOGLYPHIC ENGRAVING.—By a new process (the invention of Mr. H. Fox Talbot), paper photographs may be transferred to plates of steel, copper, or zinc, so that impressions can be printed off afterwards with the usual printers' ink.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 14th July, 1858.

1578. E. J. Maumené and L. B. Jaunay, Reims, France—Apparatus for the production of sparkling wines.

Dated 24th July, 1858.

1673. H. Wikoff, Holly-lodge, Kensington-gore—Aperient medicine to be used in the shape of a biscuit, cake, or sweetmeat.

Dated 29th July, 1858.

1712. A. Gallard, 58, Aldersgate-street—System of trusses.

Dated 5th August, 1858.

1778. J. Luis, 1B, Welbeck st., Cavendish-sq.—Waterproof tube without seams or rivets.

Dated 7th August, 1858.

1800. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Twisting bobbin.

Dated 14th August, 1858.

1864. L. A. Forot, 2, Rue Sainte Appoline, Paris—Ornamenting fabrics.

Dated 21st August, 1858.

1903. M. Benson, Craven-street, Strand — Apparatus for generating steam.

Dated 23rd August, 1858.

1912. C. Buono-Core, Naples — Composition which, when applied to substances of any kind, will render them fireproofs or uninflammables.

Dated 26th August, 1858.

1930. W. Evans, Sheffield—Apparatus for manufacturing saw backs.
1934. J. Coates, Lower Shadwell—Machinery for obtaiuing and applying motive power.

Dated 30th August, 1858.

1962. B. Hanson, Paddock, near Huddersfield—Apparatus for sizing and drying woollen yarns for warps.

Dated 2nd September, 1858.

1994. J. Bleakley, Accrington, Lancashire—Apparatus for communicating between the guard and engine-driver of railway trains.

Dated 4th September, 1858.

2008. D. Andrew, Greenock—Apparatus for obtaining motive power.

Dated 6th September, 1858.

2012. T. Warburton, Astley, near Manchester —Machinery for preparing cotton and other fibrous materials, and for doubling yarn.
2014. J. Fielden, Woodshade, near Todmorden, Lancashire —Construction or building of cops, whether of cotton, flax, silk, wool or other fibrous materials.
2016. R. A. Brooman, 166, Fleet-street—Marking words or figures on papers, parcels, books, pages, tickets, and other articles requiring to be marked, printed, stamped or addressed.

Dated 7th September, 1858.

2018. J. Shanks, St. Helen's, Lancashire—Manufacture of chlorine.
2020. J. Fyfe, Greenock—Stop-cocks or valves.
2024. F. W. Brind, 14, Devonshire-street, Bishopsgate—Sewing machines.
2025. G. Larsonnier and A. Blanche, Paris—Block-printing by hand on tissues, paper, or other suitable fabrics.
2026. L. Pellissier and J. Puytorac, Bordeaux, France—Railway breaks.

Dated 8th September, 1858.

2027. B. Hockin, Gateshead Iron Works, Gateshead-upon-Tyne—Apparatus for repairing and fitting dock-gates and their machinery.
2028. J. R. Rostron, Edenfield, Lancashire—Press for packing or pressing wool and other materials.
2029. J. O. Butler, Kirkstall Forge, near Leeds—Weighing cranes.
2030. J. F. Dickson, 6, Russell-street, Litchurch, near Derby—Construction of taps, cocks, valves, hydrants, and other apparatus for regulating the flow of water and other fluids.
2031. A. Lamb, Southampton, and J. White, Cowes—Life-boats.
2032 W. Parsons, Pratt-street, Lambeth—Apparatus to be applied to steam boilers in order to keep the surfaces of the tubular flues free from incrustation.
2033. C. Bartholomew, Rotherham, and J. Bell, Swinton—Pistons and safety-valve levers of steam and other engines.
2034. W. Parsons, Pratt-street, Lambeth—Safety valves of steam boilers.
2035. J. U. Faessler-Petzi, Lyons, France—Process for the boiling off of tussah silks or wild silks.
2036. R. A. Brooman, 166, Fleet-street—Preparation of sulphate of quinine.
2037. A. M. Peters, Edinburgh—Apparatus for regulating the flow or passage of fluids.

Dated 9th September, 1858.

2038. J. G. Newberry, Cardiff—Machine for tapping nuts, bolts, and screws, and other similar purposes.
2039. J. Luis, 1B, Welbeck-street, Cavendish-square—Life-preserver raft of buoyant mattress.
2040. W. Prisley, 7, Townley-pl., Brandon-st., Walworth—Advertising by day or night.
2041. J. Rowley, Grosvenor-terrace, Camberwell — Compound material applicable as a substitute for leather and leather cloth.
2042. W. Taylor and P. A. Baugh, Nursling, Hampshire—Apparatus for propelling ships or other navigable vessels through water.
2043. C. N. Kottula, Liverpool—Manufacture of grease for lubricating purposes.
2044. J. Tatlow and H. Hodgkinson, Wirksworth, Derbyshire—Railway-breaks.
2045. T. Timms, 1, Skelton-street, Greenwich—Bits.
2046. J. Wright, sen., and J. Wright, jun., Market-place-terrace, Caledonian-road, Islington — Apparatus used for preparing fabrics or materials to receive eyelet holes or fastenings, and fixing eyelet-holes, and in fastenings for stays and other articles.
2047. W. Nimmo, Manchester—Weaving checks in power-looms.
2048. A. Baader, jun., Mittenwald, on the Isar, Bavaria—Preparation of lubricating compounds.
2049. W. Clark, 53, Chancery-lane—Materials for dyeing and printing.

Dated 10th September, 1858.

2051. J. Parker, Bradford—Steam boilers.
2052. J. Knowles, Bolton-le-Moors, Lancashire—Machinery for preparing cotton and other fibrous materials.
2053. J. P. Kœnig, Rue de Fleurus, Paris—Surgical instrument called a pneumatic catheter.
2055. F. W. J. Johnson, London—Communicating between the passengers, guard, and engine-driver on railway trains.
2056. F. A. E. Guironnet de Massas, Gerrard-st.—Machine for decorticating and cleaning grain and seeds.
2057. W. E. Newton, 66, Chancery-lane—Water-wheels.
2058. D. Cheetham, Rochdale—Apparatus for preparing for spinning, and spinning cotton, wool, and other fibrous materials.
2059. W. Toshach, Railway Works, Bristol-road, Gloucester —Pile driving machines.

Dated 11th September, 1858.

2060. P. Journet, Paris—An improved toy.
2061. L. Hill, Port Glasgow—Apparatus for lowering or paying-out ships' chains and anchors.
2063. F. Giesbers, Great Central Gas Works, Bow Common —Manufacture of coke.
2065. H. Page, Whitechapel—Crown or round glass.
2066. J. L. Hinks, Birmingham—Tap or cock for drawing off and filtering liquids.
2067. H. Wikoff, Holly-lodge, Kensington-gore — Tonic medicine for the cure of coughs and diseases of the chest.
2068. W. H. Manning, Devizes—Candlesticks for holders.
2069. L. Kaberry and T. Mitchell, Rochdale, Lancashire—Apparatus for preparing for spinning, and spinning cotton, wool, and other fibrous materials.
2070. W. Gossage, Widnes, Lancashire—Manufacture of soda and potash.

Dated 13th September, 1858.

2071. W. Thomson, Manchester—Bleaching yarn, warps, or similar materials.
2072. G. Flageollet, Vagney, France—Self-acting mules.
2073. J. B. A. Duglèré, Paris—Separating solids from liquids for disinfecting purposes.
2074. C. W. Siemens, John-st., Adelphi—Refrigerators, and the treatment of the freezing or cooling material or materials used therewith.
2075. S. Hanbury, Birmingham Patent Iron and Brass Tube Company, Smethwick — Manufacture of tubes of copper, brass, and other metals.
2077. J. Turner, Gresham-street—Manufacture of hats.
2078. J. W. Towell, Regent-st.—Helmet.

Dated 14th September, 1858.

2079. C. J. Redpath, Limehouse—Ships' and other pumps.
2080. W. Riley, Bradford—Looms.
2081. L. Vidie, Paris—Apparatus for measuring the pressure of fluids by the flexion of diaphragms.
2082. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Coke and gas kilns.
2085. G. C. Grimes, Wandsworth—Fusees.
2086. R. Lakin, Ardwick, and J. Wain, Manchester—Spinning mules, and other machines of that class, used for spinning cotton and other fibrous substances.
2087. A. H. J. Bastable, Belgrave Works, Ranelagh-road, Pimlico—Apparatus employed in the production of light.
2088. S. St. Clair Massia, Pall-mall—Stoves or fireplaces.
2089. Hon. W. E. Cochrane, Osnaburgh-terrace, Regent's park—Fastening of railways.

Dated 15th September, 1858.

2090. Capt. F. Fowke, R.E., Park-house, South Kensington —Fire-engines.
2091. E. Smyth, Brixton — Swimming-belts and life-preservers.
2092. E. Dorsett, Old Broad st.—Portable carriage tank and furnace, to be employed for the purpose of creosoting hop poles or other timber.
2093. W. G. Taylor, Ashby-de-la-Zouch, Leicestershire — Manufacture of gloves.
2095. G. Redford, Moseley, Worcestershire—Making cartridges of metal or gutta percha, with or without bullets, and for other purposes.
2096. R. Allison, Gravesend—Apparatuses for boring and sinking.
2097. W. P. Struvé, Swansea—Apparatus for indicating strains on engine ropes or chains.

Dated 17th September, 1858.

2099. C. F. Vasserot, 45, Essex-st., Strand—Apparatus for dressing and finishing fabrics.
2100. G. Prax, Paris—Apparatus for separating the liquid from the solid portions of fecal matters.
2101. E. Welch, St. John's-sq., Clerkenwell, and J. Biggs, Norton Folgate—Tobacco press.
2103. J. H. Gresham, Kingston-upon-Hull—Copying letters, invoices, and other writings.

Dated 18th September, 1858.

2105. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Application of gutta percha for clogs, galoshes, shoes, and boots.
2106. J. Luis, 1B, Welbeck-st., Cavendish-sq. — Applying centrifugal force in the manufacture of the fecula of potato, of starch, and ultramarine.
2107. J. G. N. Alleyne, Butterley Iron Works, Alfreton, Derbyshire—Manufacture of wrought-iron beams and girders.
2108. J. B. Beasley, Cashel, Ireland—Construction of sporting and all other guns.
2109. A. Turner, Leicester—Looms for weaving.
2110. H. W. Grylls, 47, Mark-lane—Apparatus employed in submerging or laying down electric telegraph cables.
2111. T. Viears, sen., and T. Vicars, jun., T. Ashmore, and J. Smith, Liverpool—Consumption of smoke in moveable furnaces or chauffers, for heating bakers' and other like ovens.

Dated 20th September, 1858.

2113. H. Barrow, Birmingham—Cartridge boxes.
2114. H. Firmin, Wapping—Cleansing chaff and other food for horses and cattle.
2115. E. Riepe, Sheffield—Casting of steel.

Dated 21st September, 1858.

2116. G. M. Levi, Maida-vale, Middlesex—Manufacture of iron in the blast furnace.
2118. G. Dowler, Birmingham, and T. T. Chellingworth, West Bromwich, Staffordshire—An adjustible torsion spring for doors or other purposes.
2120. J. C. E. Malvezin, Paris—Manufacture of tubes, pipes, or mains for conducting liquids or gas.
2122. A. V. Newton, 66, Chancery lane—Machine for sweeping carpets and floors.
2124. A. M. Perkins, Francis-st. Gray's-inn-road—Surface condensers.

Dated 22nd September, 1858.

2126. T. B. Hubbell, Regent-st.—Hooped petticoats.
2128. F. F. Emery, Massachusetts, U.S.—Sewing machine.
2130. R. A. Brooman, 166, Fleet-street—Apparatus for printing shawls and other articles.
2134. J. Spence, Liverpool—Manufacture of steel.

Dated 23rd September, 1858.

2136. Earl of Dundonald, 12, Queen's-gate, South Kensington—Apparatus for tilling and preparing land for cultivation.
2138. H. McGrady, 21, Bridge-street, Blackfriars — Construction of flues, boiler, and other furnaces.
2140. D. Grant, Ludgate-hill—Colour-printing presses.

Dated 24th September, 1858.

2142. P. Pickering, Danzig, Prussia—An atmospheric engine.
2143. R. Ford and W. Ford, 4 Nelson-st., Perth, Scotland—Smoke consuming by means of a reciprocating or reversing fire.
2145. R. A. Brooman, 166, Fleet-st.—Manufacture of pile and cut pile fabrics.
2146. H. H. Henson and W. F. Henson, 38, Parliament-st. —Waterproofing leather woven fabrics, fibrous and other materials, and also for rendering them fire-proof, or partially fire-proof.
2147. R. Bodmer, 2, Thavies-inn, Holborn—Apparatus for preventing explosions in steam boilers.
2148. C. F. Vasserot, 45, Essex-st. Strand—Construction of spinning cards.
2149. W. Richards, Birmingham—Fire-arms and cartridges.
2150. G. L. Fuller, Lombard-st.—Steam engines.
2151. G. L. Turney, Aldermanbury—Packing pins for sale.

Dated 25th September, 1858.

2153. R. Romaine, 12, Chapel-st., Bedford row—Steam cultivators.
2155. E. Farncomb, Lambeth—Lilliputian fire-arms.
2157. W. Clark, 53, Chancery-lane — Purifying natural phosphates of lime.

Dated 27th September, 1858.

2159. S. H. Greaves, Radford-st. Works, Sheffield—Manufacturing the blades of table and other knives.
2161. W. Lander, Bristol—Engraving and printing for the purpose of ornamenting china and earthenware.
2163. W. E. Newton, 66, Chancery-lane—Cigar holders or mouthpieces for cigars.

Dated 28th September, 1858.

2165. B. Jones, York—Press wheel rollers or clod crushers.
2167. G. Mead, 7, Westside, Cambridge-rd., Bethnal-green —Construction of tobacco pipes.

Dated 29th September, 1858.

2169. J. Manning, Cambridge, and T. Paul, Houghton, Huntingdonshire—Stone staff to be used in dressing millstones.
2171. G. Old, Aston, near Birmingham, and T. Pendleton, Birmingham—Dress fastenings.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

2098. J. R. Scartliff, Wolverhampton—Burglar's detector—17th September, 1858.
2249. C. E. Bull, Wells, Norfolk—An apparatus for containing and preserving articles of value from loss or damage in cases of shipwreck.—9th October, 1858.
2265. A. Von Schuttenbach, St. Petersburgh—Imp. in lamps. —11th October, 1858.
2277. M. Sautter, Paris, Boulevart Montmartre, 14—Imp. in air-engines.—12th October, 1858.

COLT'S NEW MODEL REPEATING RIFLE.

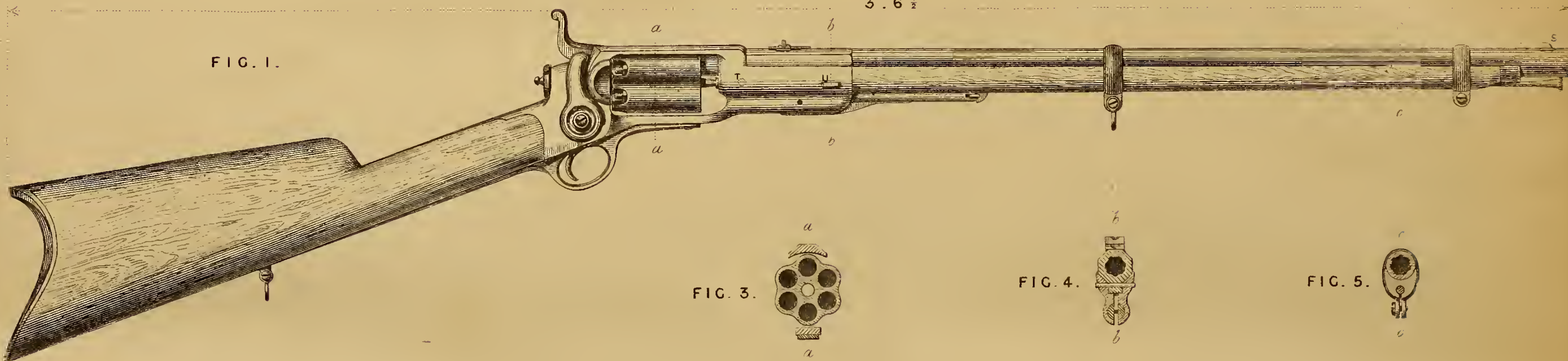


FIG. 1.

FIG. 3.

FIG. 4.

FIG. 5.

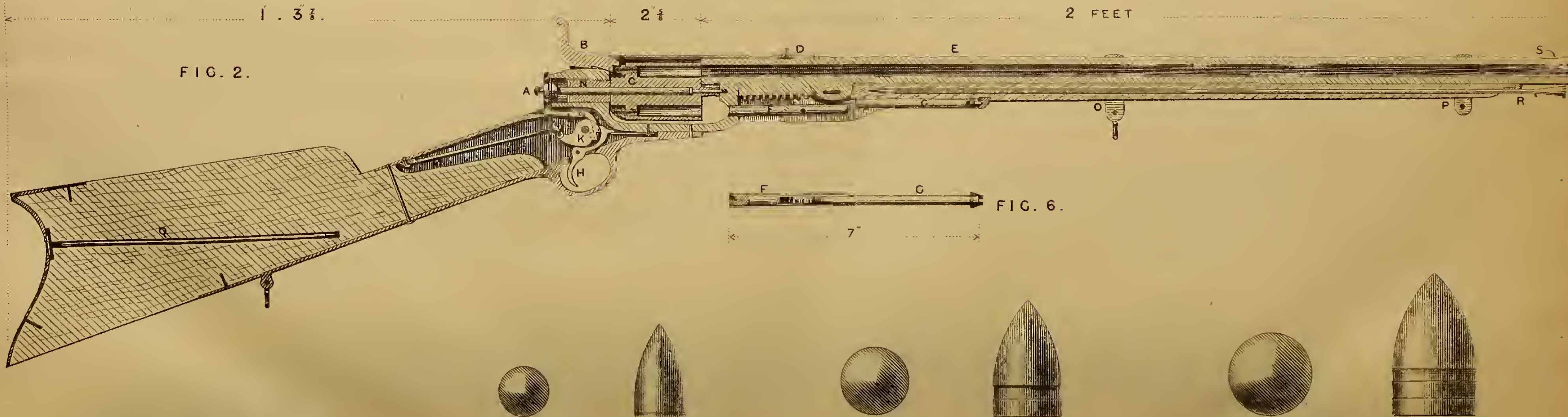


FIG. 2.

FIG. 6.

FIG. 7.

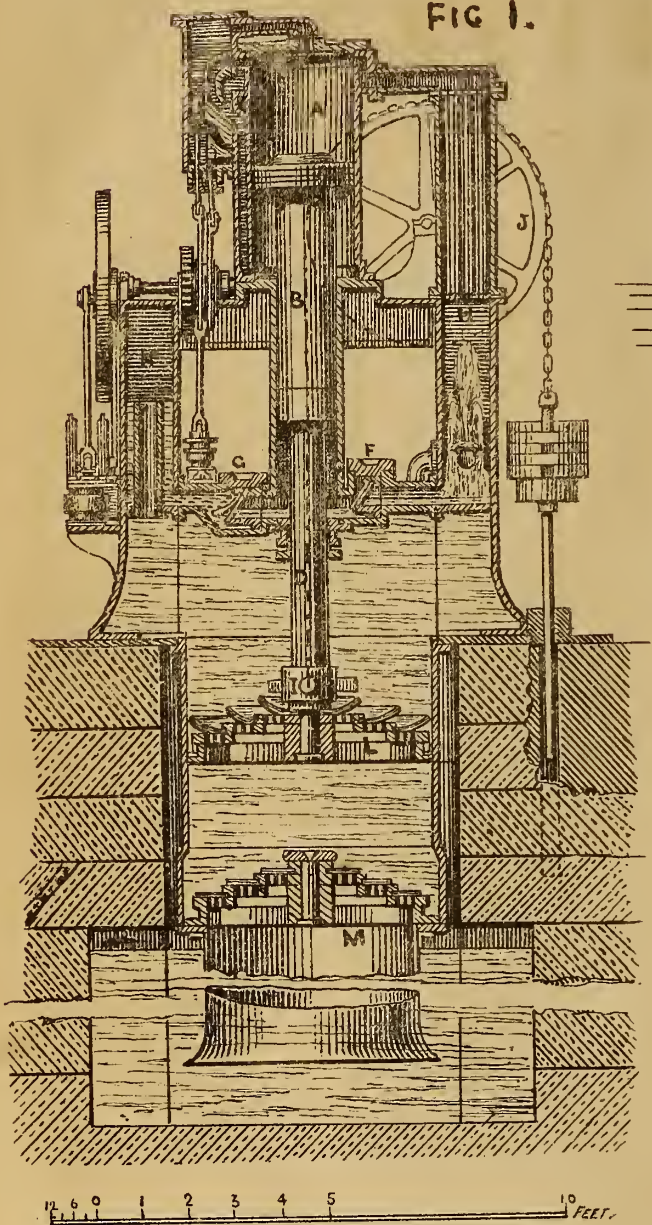
FIG. 8.

FIG 9

FULL SIZE

CARRETT AND MARSHALL'S
IMPROVED STEAM PUMPS AND WATER LIFTS.

FIG 1.

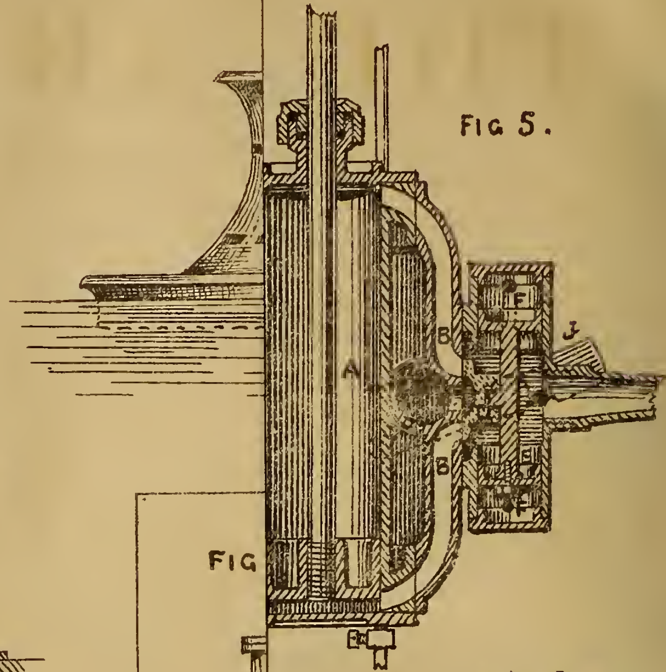


BAYLEY'S NEW FLOATING DRY DOCK.

FIG 10.

APPLICATION OF HYDRAULIC POWER
...OWING THE BELLOWS OF ORGANS.

FIG 5.



FIG

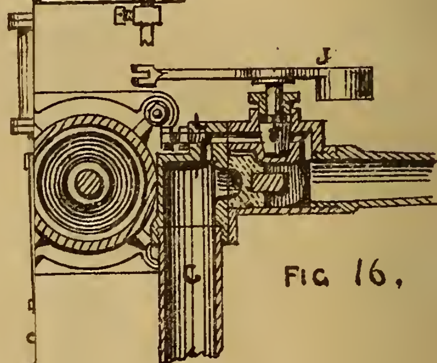
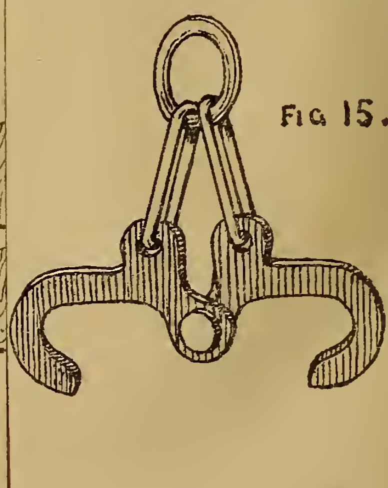


FIG 16.

...ENT SELF-DETACHING HOOK.

FIG 15.



W. Smith, C. E. Direx.

THE ARTIZAN.

No. CXCI.—Vol. XVI.—DECEMBER 1st, 1858.

NOTICE TO ANNUAL SUBSCRIBERS.

Intending Annual Subscribers for the year 1859 are respectfully requested to send in their names as early as possible in the month of December, that the new list may be made as complete as possible before the end of the present year.

Subscribers for the year 1858 who have not already made a selection, are also requested to inform the Publisher, by letter, the subject of the Plate from which they desire the proof impression to which they are entitled under the terms of the notice advertised in The Artizan for December, 1857, as it is desired by the Proprietor that the whole of the Subscribers—Home, Foreign, and Colonial—shall be supplied with their proofs before the end of the present year.

Subscribers are also requested to instruct the Publisher by letter how their proofs are to be addressed and forwarded.

The subscription for the twelve Monthly Numbers of The Artizan, forwarded free to any part of the United Kingdom, is twelve shillings, if paid in advance; and it may be paid in postage stamps, or receipt stamps; or, if by draft or post-office order, to be made payable to the "Proprietor of The Artizan."

COLT'S NEW MODEL REPEATING RIFLE.

(Illustrated by Plate cxxxiv.)

The late war, and the recent mutiny in India, if they have done nothing else, have established the reputation of Colt's revolvers and shown the necessity for revolving breech-loading arms, more especially for cavalry; and we cannot doubt that after the experience of these struggles, it has been, and will be, more largely adopted in foreign armies, and we may hope that it will be largely introduced into our own.

It is not too much to say that to their rifles the Americans owe their independence. Men trained to the use of the rifle at ranges of from 250 to 1,000 yards would be well adapted to disperse artillerymen and reconnoitring parties, or to annoy columns advancing to attack. Musketry at such distances is perfectly harmless, but every bullet from rifles in well-trained hands tells, and six men each armed with a six-shot revolving rifle may be surely considered a match for 30 men armed with even the single-barrelled Enfield rifle, as there would be no time lost in loading; and by the system of loading at the breech, a skirmisher need not expose himself to the shot of the enemy during that operation, as it is so very difficult to avoid doing with the muzzle loader.

The revolving rifle of Colt has been used with great effect by Catlin, the celebrated American hunter, in his expeditions into the vast forests of the interior, and by some of our officers at the Cape and in India, and on many occasions the power of firing six shots before reloading has rescued them from situations of great danger. They pronounce it an irresistible and efficient weapon, which may be always relied upon, and affords an unfailing resource.

The power, efficiency, and applicability to military uses, of these rifles has been severely tested and satisfactorily proved by the American Government, who, we are informed, have ordered several thousands of them for the equipment of a body of picked men.

This weapon, as will be seen by our illustration, has a neat, business-like, serviceable appearance; and, as regards weight, it is not more heavy or cumbersome than the ordinary double rifle, its weight varying, according to the length of barrel, from 7 lbs. to 12 lbs., each with five and six shots.

In its internal construction it differs in some respects from the pistols and early revolving rifles, for the catch which causes the breech cylinder to revolve, instead of acting against ratchet teeth cut on the cylinder itself, works in teeth cut on the circumference of the cylinder end of the base pin in such a manner that the base pin rotates with the cylinder itself, being locked by a small mortice in the cylinder, and the stop bolt gears into corresponding notches also cut in the end of the base pin, and thus locks it when required. This is a very great improvement, and by a simple arrangement the small spring catch, which by means of a circular groove on the front end of the base pin keeps it in place, is immediately released by pressing on a small stud, and the cylinder can be instantaneously removed or replaced.

Instead of the pin which in the pistol is used to let the hammer down on, when carrying it, a small recess is cut between each nipple, in the cylinder itself, into which the hammer fits when let down, and makes security doubly secure.

Fig. 1 is an elevation and Fig. 2 a longitudinal section of the middle-size rifle, with a 2-ft. barrel.

Fig. 3 is a cross section through cylinder and lock frame on the line *a a*.

Fig. 4 is a cross section through barrel and lock frame on the line *b b*, showing the key, U, by which the barrel is attached to lock frame.

Fig. 5 is also a cross section through barrel and stock, showing band which keeps the barrel and stock together, taken on the line *c c*.

Fig. 6 is a plan or view of the under side of the lever ramrod, with the end in section, showing the recess into which the top of the bullet fits when ramming it down, and thus prevents its shape being injured. F, the ramrod; G the lever.

Figs. 7, 8, and 9, are full-sized conical and round bullets for the large, medium, and small-bored rifles; each size has barrels of 18 in., 21 in., 24 in., 27 in., and 30 in. in length, and the Military Rifle is 33 in. in the barrel, exclusive of the bayonet. They vary in weight from 7 lbs. to 12 lbs. according to length of barrel, and have five and six shots. Sections *a*, *b*, and *c*, are of quarter full size

A, Fig 2, is the base-pin, which revolves with the cylinder. By setting he lock at half-cock, and pressing in the small stud, T, Fig. 1, the pin may be pulled out, and the cylinder removed or replaced as easily as possible. B, hammer; C, cylinder containing charges; D, sights, from 300 to 600 yards; E, barrel; F, G, lever and ramrod; H, trigger and sear spring; I, main-spring stirrup; K, tumbler; L, bolt which locks cylinder when firing; M, main spring; N, screwed bushing to adjust cylinder; O, P, loops or bands, which keep the barrel and stock together; Q, R, wiping-rod, the end, Q, being contained in the hole in butt of stock, and screws on to the end of the longer piece when required for use. S, Figs. 1 and 2, sights. T, Fig. 1, spring catch, by pressing on which the base-pin is withdrawn, and the cylinder can then be removed; U, key by means of which the barrel is attached to lock frame. The nipples are removable, and can be readily taken out by means of the key provided for that purpose.

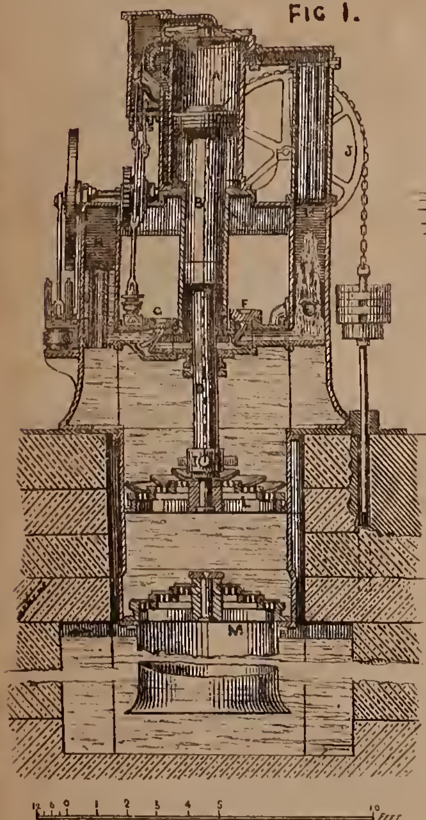
As regards our army, we consider it absolutely necessary for our own honour and safety that in the matter of arming our soldiers, we should, *at least*, keep pace with our friends, especially as a portion of the French army is now being armed with double-barrelled rifles; and as our army must ever be a small one, our object should therefore be to make up by *efficiency* for what we want in *numbers*, and this can be done in *no way so surely* as by the use of the *revolving rifle*; and we should not only make our men *good marksmen*, but give them the *best weapons*.

We do not see why our young men should not get up rifle clubs throughout the length and breadth of the country, using this weapon, and becoming expert marksmen.

We will conclude these remarks by an extract from a writer who was present at a Saturday afternoon's shooting match at a town in Switzerland:—"One of the shooters put 19 bullets successively into the bull's eye at 200 yards! Now this must be considered admirable

CARRETT AND MARSHALL'S IMPROVED STEAM PUMPS AND WATER LIFTS.

FIG 1.



BAYLEY'S NEW FLOATING DRY DOCK.

FIG 10.

G. RENNIE'S, FLOATING BATTERIES.

FIG 2.

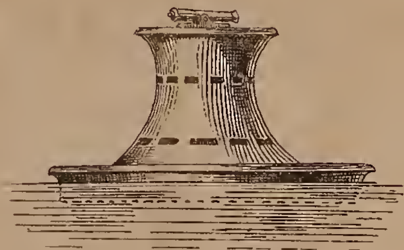


FIG 3.

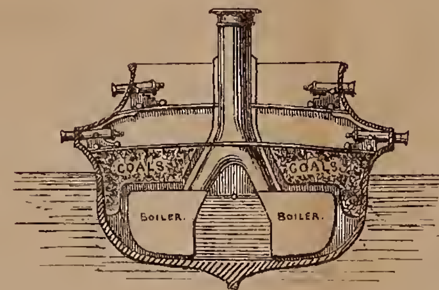


FIG 4.

JOY'S APPLICATION OF HYDRAULIC POWER TO BLOWING THE BELLOWS OF ORGANS.

FIG 5.

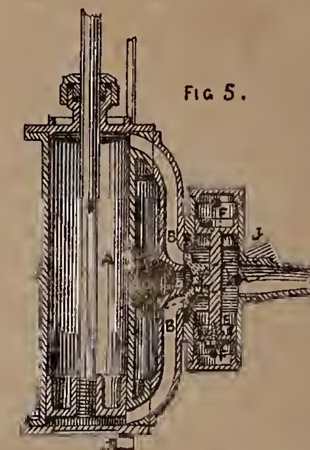
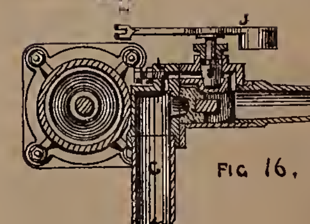


FIG 16.



W. WEALLENS' PARABOLIC GOVERNORS

FIG 6.

FIG 7.

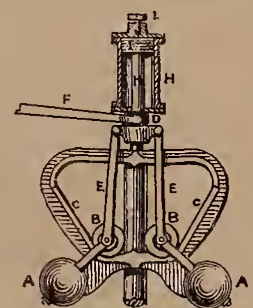


FIG 8.

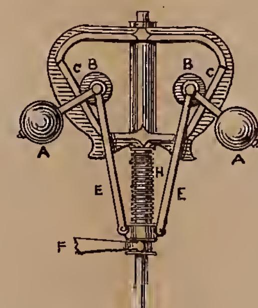
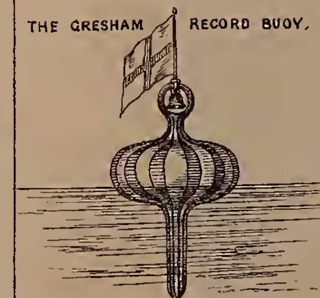


FIG 9.

THE GRESHAM RECORD BUOY.



F. GALTON'S, HAND HELIOSTAT.

FIG 11.

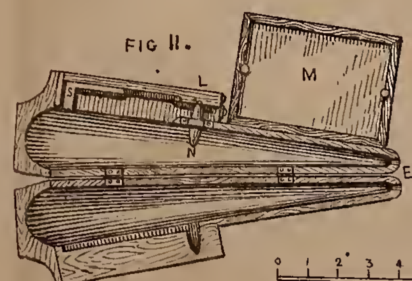
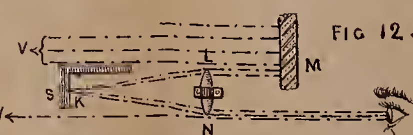


FIG 12.



Scale of Inches.

0 1 2 3 4 5 6 12

FIG 13.

CAPTAIN TALBOT'S, PATENT SELF-DETACHING HOOK.

FIG 14.

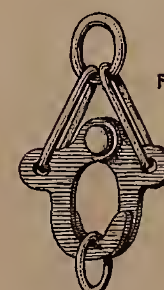
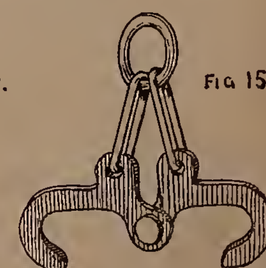


FIG 15.



practice, considering that the men were *not professional marksmen*, but simply village tradesmen; when it is further considered that these shooting clubs exist in *every part* of Switzerland—that an enormous percentage of the small population are in possession of rifles—indeed, that in no country in the world are there, in proportion to the population, so many marksmen and rifles—it will be obvious to the most careless of observers the vast power this little country possesses to resist invasion." The hits in the bull's eye averaged 80 per cent. of the shots.

The excellence of this practice. exceeds, we believe, the highest standard of accuracy attained by any corps in the British army, and it is much to be regretted that the old-fashioned stupid notions which prevail amongst our military authorities should have so successfully hitherto obstructed the introduction of breech-loading rifled small arms, except pistols, and that arm only to a very limited extent. It is not amongst the old and infirm of those who officer our army, and who preside at Pall Mall, Woolwich, and elsewhere, that the very absurd notion exists that the more ready means of rapidly firing a number of charges would induce the practice amongst soldiers under fire of discharging the whole contents of their multi-chambered pieces as rapidly as possible, without regard to effect and without order; it is not, we repeat, solely amongst the old, infirm or imbecile, the men who should be superannuated, and not permitted to interfere with the organisation, equipment, or management of our army that such opinions are expressed; but also among the younger, and we had hoped more intelligent men, placed in command and in offices of trust, power, and influence; men who have to select the material and command the men obtained at great cost for the maintenance of our rights, and the protection of our vast possessions throughout the world; it is by them also that this to us very absurd notion is urged as a reason for arming the various branches of the military service with the most inefficient, awkward, and unreliable arms or implements of war with which they are expected to perform their duties. Why, then, in the name of all that is sensible, do they not urge that swords, instead of being sharp-edged, should be round and blunt; and bayonets which, instead of being sharp-pointed, and sharp-edged, should be blunt? Surely there is as much reason in favor of the one as for the other. Are our men to be placed before an enemy under the greatest disadvantage as to the quality of their arms, their killing powers, and the facility for loading and firing them?—for it is only when the necessity for the use of such tools exists, that the greatest advantage is to be derived from the greatest facilities which can be offered for their rapid and facile use. From another point of view the absurdity of this opinion when advanced by military men against the employment of breech-loading arms appears in an equally unfavourable light, as we fear it would augur ill for the state of discipline of the army, for the efficient teaching, for the state of efficiency, competency, and education of the officers who have to direct the movements in detail of bodies of men when actually engaged; as otherwise no such irregularity or breach of discipline could occur with men properly trained to the use of an efficient weapon, by which they have become familiarised with the properties of the instrument placed in their hands, and which will give them confidence in its practical management in actual service.

It is much to be regretted that the Executive military officers connected with the War Department, whose duty it is to investigate inventions and improvements submitted to them officially, cannot perform their duties thoroughly, and unbiassed by a prejudice against all that is new, because it is new, and who continue to maintain that that which is old and long used is best, because it has long been used and is well known, and who believe that nothing good in military weapons, arms, projectiles, or military *material* of any sort invented or suggested by non-military persons can be worthy of their consideration, or deserving of adoption in the service; and, in support of this assertion, we have no hesitation in affirming that the talent of such eminent men as Whitworth and W. G. Armstrong is treated with great disrespect by the military element of the Woolwich Committee, because they have dared to presume to know something about the true principles of construction which should be followed in producing rifled arms superior in accuracy of fire at increased ranges, and with increased power of penetration; and because they have been able to combine all these with the advantages, in the case of rifled cannon, of a considerable reduction of weight of gun for a given weight of shot, and also that they can be more easily and rapidly loaded and fired. Now, it is worthy of remark, that scarcely a single improvement of any moment, and certainly not one great or radical innovation and improvement has ever been proposed, made, or effected, in any branch of the practical and operative departments connected with the Ordnance or War Department of the State by military men, but, almost without exception, nearly all such have been proposed or originated by non-military or civilians; and even the great military text-book or standard work on "Strategy," used in military academies, was written by a Cantab, who probably never carried a more warlike instrument than a birding gun, and who possibly was never present at a military field-day or sham fight; and as for the mechanical contrivances, means and appliances for producing every description of arm, weapon, projectile, or article of any sort, in any of the military departments of the Government, they are entirely due to the talent and genius of civilians, and to no one man in a greater degree than to Mr. John Anderson, of Woolwich Arsenal; but for whose mechanical ability, and his readiness of application and adaptation of mechanical means, the Executive officers, the Military Committee of Woolwich, and the entire War Department, would, in our opinion, have cut but a sorry figure during the exigencies of the late war. Yet the jealousy which has always existed on the part of military officers against civilians so circumstanced, even when they had been entirely dependent upon them, is so great as to operate in keeping as far as possible in the background such men as Mr. Anderson; and, although they have ever been ready to take credit for what he and others have done, they are always ready to visit upon such men the odium of any want of success, however or from whatever cause such may have resulted.

Now, until this condition of things is entirely changed, and mechanical experience and skill are permitted free action, and mechanical men holding executive situations under Government assert their rights and obtain a recognition of their services, with its corresponding responsibilities, and are uncontrolled by the incompetent and injurious interference of military amateurs in mechanics, there is but little hope for the same real advancement and progressive improvements which are taking place in every other branch of arts, science, and manufactures but those connected with military matters, or we should hear no more of such absurd objections as that urged by military men against the introduction of breech-loading and multi-charged fire-arms and ordnance; when, however, this change is effected, we shall see the British army, which has always possessed the highest reputation for unflinching courage, prowess, and endurance, armed with revolving rifles and rifled carbines, and thus equipped they will not labour under the disadvantage of being sent into the field with inefficient weapons, to be shot down like dogs, or to rely upon their individual muscular powers rather than their excellence in the use of long ranged weapons.

That the general adoption of such an arm as Colt's rifle in the British army would effect a great and beneficial change, no sensible man can for a moment doubt, and we hope the day is not far distant when such a weapon will be in the hands of every private soldier, and that he will be properly taught its use that he may be able to employ it with the greatest advantage.

DECIMAL COINAGE FOR CANADA.

During the whole of the month of November just past, the Royal Mint has been occupied to the fullest extent of its means in the production of a new coinage, on the decimal principle, for Canada. It consists of 20 cent, 10 cent, and 5 cent pieces of silver, and 1 cent pieces of bronze. The 20 cent is of the same size and weight as the franc of France; and the 10 and 5 cents correspond with the half and quarter francs of the same country. The bronze pieces, too, are identical in size and diameter with the 5 centime of the reign of Napoleon III. The designs for the new coinage are the production of Mr. Leonard Wyon, and they are certainly not below the average merit of that artist's other works. The obverse of the 20 cent piece exhibits a well-engraved likeness of the Queen. A laurel wreath decorates the head of Her Majesty, and the words "Victoria Dei Gratia Regina, Canada," surrounds the whole. The protecting edge is somewhat broader and better defined than that of the shilling, and therefore the new coin has a more finished appearance, and will wear better. The reverse of the 20 cent, at first glance, resembles much the *Victoria* silver home coinage. A closer examination reveals, however, a considerable difference. A wreath of maple leaves fills the place of that of laurel and oak, with which the shilling and sixpence have made us so familiar. And this, besides being surmounted by a crown, encloses the figures and words, "20 cents," and the date, 1858. The maple tree is abundant in Canada, and hence, probably, the cause of the selection of its sycamore-like leaf for this portion of the embellishment of the new coinage. The smaller silver pieces are in design but reduced *fac-similes* of the larger, and they are of neat workmanship and appearance.

The bronze piece has a richer hue than that of the British copper coin, and although not nearly so large or so heavy as the halfpenny, bears a value nearly coincident with it. The obverse resembles closely that of the silver pieces, but the reverse is something different. Maple leaves, prettily undulated, run round the whole of its circumference, and enclose the words "one cent" and the date, "1858." Seventy thousand pounds' worth of the silver decimal coins, or, in number, about 3,000,000,

constitute the present requirement for Canada; whilst the 30 tons weight of bronze will number 4,400,000 individual coins!

It seems to us that the Colonies are far in advance of the Mother Country in adopting the vast improvement of a decimal currency. Now that John Bright is hatching a Reform Bill, it is a pity that he cannot supplement it by a proposition for the reform of our *effete* system of weights, measures, and notation, and for placing the coinage of the kingdom, at least, on a footing of equality with our own dependencies and the nations of the continent. The subject is far from being beneath the notice of a man who aspires to be a legislator and statesman. We commend it to Mr. Bright's serious reflection. It is thought that the quantities above referred to will have to be doubled next year.

THE PATENT DERRICK.

IN the last number of THE ARTIZAN we gave our readers a description of the large iron floating derrick which had just previously been launched from the yard of the Thames Iron Works and Ship Building Company at Blackwall; and we gave a short history of the origin of boom derricks, and described the construction of fixed, moveable and floating derricks, and the mode of working them, and the advantages to be derived from their use in various situations and under various circumstances.

A small wooden derrick, which was built some time ago at Charlton, has been engaged in raising vessels, and in hoisting and placing boilers and machinery for various parties; the latter operation the derrick has performed very satisfactory, but former attempts at raising sunken ships have been anything but successful, as in the instance of the steam-tug *Vanguard*, which was so clumsily and imperfectly performed that not only was the vessel's back broken during the operation, but it is said that part of the vessel is still left embedded in the mud, and which, unless removed, may eventually prove a source of great inconvenience and interference with the navigation. It must, however, be explained, that the want of success which has until now attended the employment of Bishop's patent derrick for raising vessels has not arisen from any defect in the principle of the floating derrick, nor from any defect in its construction so far as we have been enabled to learn, although we consider the system of construction which Mr. Bishop employed in building the vessel or scow was defective and ill-suited to take the strains to which it would be subjected by the super-imposed derrick boom when raising any weight nearly approaching that at which the small derrick was designed to work; however, it has now been successfully employed in lifting out of deep water, and stranding, the *Lightning* brig.

This vessel, which was sunk in the Thames, off Erith, about four months since, through collision with the screw steamer *William France*, was, on Tuesday, 23rd November, raised by the small floating derrick belonging to the Patent Derrick Company, and placed close in shore for unloading and repair. Several partially successful attempts to raise the brig had previously been made; still, the undertaking may fairly be characterised as one evincing somewhat more zeal than discretion on the part of the Derrick Company, since the brig's registered tonnage is 176, and when sunk she had nearly 300 tons of granite in her hold, while this small derrick has only a hoisting power of 100 tons, it having been constructed chiefly for lifting and transporting steam-engines, boilers, &c., about the Thames, below bridge.

The dead weight against the derrick was therefore considerable; but no ways daunted by the odds, Captain Coppin and Mr. Barter (one of the directors of the company), by whom the final operations were planned and conducted, devised a means of making up for the derrick's deficiency of power by imparting additional buoyancy to the brig. This was effected by forming a platform and bulkheads fore and aft within the wreck, thereby obtaining considerable additional displacement, with the combined aid of a pair of powerful pumps, invented by Captain Coppin for wrecking purposes, and capable of ejecting 4 tons of water per minute.

Operations were commenced at about half-flood by setting these pumps to work and coupling the lifting chains "bent on" to the brig to others rove through the purchase-blocks of the derrick's lifting boom. The hoisting gear of the derrick, which is worked by steam power, was then put in motion, when gradually the unfairly taxed powers of the little derrick, aided by the rise of tide, succeeded in "weighing" the brig, and placing her close in shore, within four hours of starting. The result must be most satisfactory, both to the Thames Conservancy and to the commanders of sailing craft passing up and down the river, as the wreck lay just off the point of Erith Reach, and was greatly in the way of tacking vessels. Had not the derrick succeeded in raising the *Lightning*—a feat which, while furnishing an obvious joke to the 'long shore public, also excited in their minds considerable doubt—the removal of this serious obstruction to the river's navigation could only have been effected by breaking the vessel up.

That these floating derricks will greatly aid the Thames Conservancy in keeping the river free from similar constantly recurring obstructions is evident; in fact, the frequent collisions near the mouth of the Thames promises continual employment for the invention. At the present time there are several wrecks near Gravesend, which expose vessels to the delay and loss that would be consequent upon the fouling of anchors. It is highly desirable that these should be removed forthwith; still, it behoves the Derrick Company, as a new institution, to act with more discrimination and less zeal than has been evinced in the case of the *Lightning*. Between the company's little derrick, with its 100 tons hoisting capacity, and their monster machine with tenfold that power, there is ample scope to grapple all exigencies without risking success, and ample employment for the invention of a highly remunerative character.

TRIAL TRIP OF THE "OMEO."

THE fine new screw steam ship *Omeo*, built by Messrs. Andrew Leslie and Co., of Hebhurn Quay, Newcastle-on-Tyne, for the Australian trade, and fitted with auxiliary engines and boilers on a new principle by Messrs. R. Morrison and Co. of the same place, and which bids fair to commence a new era in ocean steam navigation, underwent an official trial trip on the Thames, on the 10th inst., where her speed and carrying capacity was put to the test at the measured mile.

The vessel is 220 ft. long, 30 ft. 6 in. beam, and 18 ft. 6 in. deep, full rigged as a clipper ship; the lower masts are constructed of iron plates, on a principle adopted by the builders to ensure sufficient strength. Into those masts are conducted the smoke from the cabins and other fires, so that the annoyance often felt by passengers from the smoke on deck is entirely obviated, and, in addition, the various compartments of the vessel are thoroughly ventilated by the continued flow of air from them through the mast heads. At the time of the trial trip the ship had on board 1,000 tons of cargo and ballast, to enable the gentlemen acting on behalf of the owners to judge fully the power of the machinery to propel the ship.

The engines are on R. Morrison and Co.'s direct acting high pressure expansive condensing principle, 100 horse nominal power, and occupying less space in the ship than any other of equal power, the space occupied by the base plate of the engines being 6 ft. 'thwart-ships, by 9 ft. 6 in. fore and aft, including donkey engine; whilst that occupied by the boilers is 11 ft. 6 in. square.

On the trial trip, the pressure of steam in the boilers was 60 lbs to the square inch, cut off in the cylinders and expanded so as to enter the condenser of 9lbs or 6 lbs below the pressure of the atmosphere.

The cylinders are double, with steam from the boilers surrounding the working part, and otherwise covered and protected from the cold to prevent condensation and give out the full effect of the steam as nearly as possible.

The starting and reversing gear are on a new principle, arranged in such a manner as to give the engineer full and instantaneous command over the engines.

The boilers are on Mr. R. Morrison's patent upright cone-flued double chimney principle, with the fire at the bottom of the cone or fire-box. The shell of these boilers, as well as the coned fire-box, are cylindrical, consequently able to stand a much higher pressure than the ordinary description of marine boilers, whilst their evaporative power is greater, having no small tubes or other complicated part inside; and from the upright position of the coned fire-box it is almost impossible for any deposit of salt or mud to take place on the plates, as, on examining the inside of the boilers after the run from the Tyne to the Thames, the plates were found quite clean. This is a most important element in marine boilers for high pressure purposes, and will be found of much advantage to steam shipowners trading on foreign stations, where repairs are so expensive. On the top of those boilers a steam super-heating chamber is formed, from where it is taken to the cylinder in a highly rarified state. The ship was trimmed nearly on even keel, drawing 13 ft. forward, and 13 ft. 4 in. aft. Speed about 9 knots per hour; engines working up to 426 horses' effective power. The coals were carefully weighed, and the consumption found to be 2·4 lbs per effective horse-power per hour, exerting 6·57 horse-power per square foot of fire grate surface. And when it is stated that 4·5 lbs of coal per effective horse-power is the lowest consumption of a well constructed marine engine of the ordinary class, the advantages of these engines and boilers will become more apparent, and no doubt they are a step in the right direction to make ocean steam ships more remunerative to their owners than of late they are supposed to have been; the enormous consumption of coals at present, in most cases, being such as to prevent many important trades being carried on profitably by steam power. An auxiliary screw steamer, with machinery as described, and making the passage from the Thames to Calcutta in 77 days, would require 839 tons of coals, steaming full power the whole distance, whilst a similar steamer, with the ordinary engines, and exerting the same power, would require 1,570 tons of coals for the same voyage; and looking at the price paid for coals at foreign stations on the route to India, China, and Australia, the loss of cargo, space, and freight, by the large amount of stowage room taken up by coals to supply the present large consumption, we may safely state that those who will reduce the evil to its minimum condition, will give a stimulus to ocean steam navigation hitherto unknown.

Want of space this month prevents us giving two woodcuts of the indicator-cards taken from these engines when developing the power shown with $8\frac{1}{2}$ cwt. per hour, or 2·28lbs. per H. P. per hour.

LAUNCH OF THE RUSSIAN FRIGATE "GENERAL ADMIRAL" AT NEW YORK.

The keel was laid on the 21st of September, 1857. The model is what is called the long, flat floor; with full bilge, sharp end, round stern, no poop nor cut-water, and short forecastle deck. She is expected to attain a speed of 14 knots under sail, and her draught of water will not exceed 25 feet. Her dimensions are:—length on spar deck, 307 ft.; breadth, 55 ft.; length over all, about 325 ft.; depth to spar deck, about 34 ft. She is pierced with 44 side ports and 2 stern ports on lower deck, and 30 side ports and 4 large ports forward, and 4 large ports aft on spar deck. Her armament will consist of 40 shell guns of large calibre on gun deck, and 20 long guns and 2 pivot guns of the largest size on her spar deck.

The ship is built of white oak. Her keel is composed of two pieces, laid with a curve of 6 in. in its length, siding 19 in., and moulding 27 in.; in addition to which there is a false keel fastened with copper. The stern sides 16 in., and moulded at head 16 to 17 in.; at heel 30 to 36 in., fastened with copper. The apron is of live oak, sided 18 in. The hawse timbers and nightheads are also of live oak. The rudder post sided 12 in. at keel, and moulded at keel 18 to 20 in. The propeller post is composed of white oak, siding 19 in.; the inner post of live oak, also extending from the keel to the upper side of the gun deck beams, sided fore and aft 16 to 18 inches, and sided at propeller hole 36 in. The keel, stem and stern frame are thoroughly coaged and fastened with inch and a half copper bolts. The frame is of the best quality of white oak. The floors extend from bilge to bilge, siding 22 in. and are of colossal dimensions. The first futtocks are 21 ft. long, sided 14 in. The second, third, fourth, and fifth futtocks are 15 ft. long and sided 13 in. The top timbers are 23 ft. long, siding 13 in.; half-top timbers 14 ft. long, siding 13 in. The moulding, size of frame at centre of floor is 21 in., diminishing to $8\frac{1}{2}$ in. at spar deck port sill. The floor is filled in solid to two feet beyond the head of the first futtock, and caulked both inside and outside, and bolted to the keel with $1\frac{1}{2}$ in. copper bolts. The propeller well is constructed on an entirely new principle, of hectagon shape, and combining great strength. The centre kelsons are of two depths; siding 19 in., and moulding 20 in. The scarphs are 10 feet long. The kelsons are coaged to the frame, and to each other, and to the deadwood, with live oak coags and $1\frac{1}{8}$ copper bolts drawn through and riveted on the under side of the keel on composition rings. The sister kelson is of white oak, 16 by 16; the scarphs 7 ft. long, and fastened to the floor of main kelson with lignumvitæ coags, and 9-8th in. copper bolts. The deadwoods, forward and aft, are of white oak siding, 18 in., coaged and fastened with copper bolts drawn through and riveted. The boiler kelsons are in two depths and two breadths, each 15 by 17, and extending well forward and aft. The engine kelsons are of live oak, coaged to the frame and to each other with live oak coags, and fastened with copper bolts. The port sills are also of live oak. The frame is double braced with iron plates, 5 by $\frac{7}{8}$, placed about seven ft. apart and extending from two ft. below the first futtock head to the spar deck frame, and fastened to timbers with inch iron bolts drawn through and riveted on outside of the timbers, and riveted to each other at the crossings. There is also an immense iron truss or cord plate, 6 by $1\frac{1}{8}$ inch, running at the top of these braces all around the vessel, fastened through the ends, and riveted outside of the timbers. There are two courses of 5 by $\frac{7}{8}$ inch iron plates on the outside of the timbers, at the end of the spar and gun deck beams; also iron plates on the outside, aft by the rudder post, $4\frac{1}{2}$ by $\frac{7}{8}$ inch. The beams of the spar and gun deck are secured at the fore and main-masts, and around the propeller well, with 5 by $\frac{7}{8}$ inch iron bolts, running diagonally from side to side of the ship, with their ends bent and fastened to the timbers of the frame. The ceiling in the hold is of pitch pine, 10 in. thick to the head of the second futtock, and thence to berth deck clamps, 8 in. The breasthooks are of white oak, of great length, siding 15 in. and fastened with inch and a quarter copper bolts, driven from the outside and riveted on composition rings. The *General Admiral* has four decks. The orlop deck beams are of pitch pine, siding 13 in., moulded 10 in., decked with 6 by $3\frac{1}{2}$ white pine; the berth deck beams of pitch pine, sided 16 in., moulded 14 in., and decked with white pine 6 by 4; the gun deck beams pitch pine, sided $17\frac{1}{2}$ in., moulded 14 in., decked with pitch pine 6 by $4\frac{1}{2}$; the spar deck beams sided 14 in., moulded at $14\frac{1}{2}$ in., decked with pitch pine plank 6 by $4\frac{1}{2}$. All the hanging knees to the decks are of white oak, of unusual size, thoroughly fastened with nine-eighths and ten-eighths iron bolts, run from the outside of the timbers and riveted on the face of the knees on iron rings; those of the spar deck being dagger knees. All the stanchions to these decks are of locust, having iron bolts passing through them, thus securing the beams of the deck to each other and to the bottom of the vessel. The outside plank is about half on, and is of white oak. The beam plank is of white oak. The garboard strake 11 in. thick, rabetted into the keel. The next strake is 9 in. thick, and the next 7. These strakes are bolted laterally to the keel and to each other with galvanized iron bolts, and to the frame with inch copper bolts riveted inside, and $1\frac{1}{8}$ locust treenails wedged on the inside. The bottom plank is 5 in. thick. The main rail is of white oak, 7 in. thick, and her bulwarks are planked up solid. She has hammock rails extending from the foremast to the mizen mast.

The *General Admiral* will be propelled by two direct horizontal engines, each cylinder of which will be 84 in. in diameter and 3 ft. 9 in. stroke, with a nominal power of 800 horse, but an actual horse-power of about 2,000. The propeller will be $19\frac{1}{2}$ feet in diameter, and is one of Griffith's patent, and can be raised out of the water at pleasure. She will have six horizontal tubular boilers, which are now building at the Novelty Iron Works. The ship will be rigged as fully as if no steam was to be used. On being launched she drew only about 11 ft. forward, and 12 ft. 6 in. aft. The ship is to be ventilated in a manner and to an extent never before attempted, by the introduction of pipes between the timbers and inside of the ship, which connect with a blower driven by an engine fitted expressly for this purpose, thus giving a full supply of fresh air between decks, and at the same time preserving the timbers from decay.

WEALLENS' PARABOLIC STEAM-ENGINE GOVERNORS.

(Illustrated by Fig. 7, Plate cxxxv.)

This invention, by Mr. W. Weallens, engineer, of Newcastle-upon-Tyne, relates to the employment of controlling mechanism, for preventing an excess or accumulation of momentum in the balls of parabolic governors. This mechanism consists of an air cylinder similar to the "cataract" employed in pumping engines, or a spring or weight, the action of which will be to offer a certain amount of resistance to the balls when they change their height; or this effect may be accomplished by a modification of the parabolic curve in which the balls or gear connected therewith travel. In applying this governor to steam-engines, it is proposed to use it in connection with an expansion valve, in place of with the throttle valve, so that the power of the engine will be increased or diminished by varying the degree of expansion.

Fig. 7, Plate cxxxv, represents a side elevation of one form of the improved parabolic governor suited for working a regulating valve; and Fig. 6 is a section, taken through the guard or sweep of the same. A, A, are the governor balls, connected by short stems with the antifriction rollers B, B, which travel with the balls, the latter describing a parabolic curve when ascending or descending upon the sweep C, C. The rollers are connected in the ordinary manner with the slider D by means of two links E, E, and the slider by rising and falling imparts motion to the lever F, which is connected at its opposite end with any convenient form of regulating the throttle valve. An air cylinder H is attached to, or connected with, the slider D, within which cylinder is a piston I, attached to the spindle K of the governor. In the upper cover of this cylinder is a small opening or inlet, the size of which is regulated at pleasure by the conical screwed plug L. The governor spindle may be rotated either by bevel gearing, as shown at M, or by a chord and pulley, or other convenient arrangement; and as the balls, by reason of a change of speed in the engine, move upwards or downwards, this motion will be limited and controlled by the greater or less freedom with which the air is allowed to escape from or enter into the space above the piston in the upper portion of the cylinder, which passage of air is capable of being nicely regulated or adjusted by raising or depressing more or less the plug L. It is thus obvious that this air orifice determines the time in which sufficient air can be forced out of or drawn into the cylinder to produce an equilibrium of pressure with that of the external atmosphere, and consequently the speed with which the governor balls will rise or fall. Fig. 8 represents an elevation of a modified form of apparatus for controlling the rising and falling motions of the governor balls. In this modification a helical spring H is substituted for the air cylinder previously referred to. The balls in this arrangement cannot obviously rise without compressing the spring H, which will offer sufficient resistance to prevent any undue momentum in rising. The patentee's specification also describes plans in which a weight is substituted for the purpose of controlling the momentum of the balls, and preventing their too rapid action, such weight being applied to the under side of the lever F, or of the working centre or axis of the same; also another modification, in which the form of the curve of the sweep C is changed, for the purpose of controlling the regulating action of the balls. In this case the curve of the sweep is made rather sharper at the extremities, where they will offer greater resistance to the rising and falling of the antifriction rollers, and will therefore considerably reduce the momentum of the ascending or descending parts.

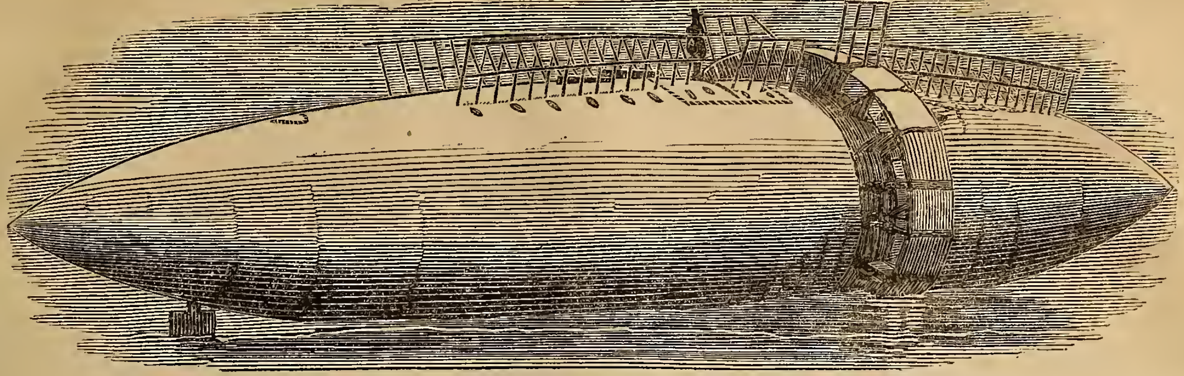
CAPTAIN TALBOT'S PATENT SELF-DETACHING HOOK.

The following is Captain the Hon. William Talbot's description of a self-detaching hook recently patented by him:—

"When lowering and disengaging boats from ships, considerable difficulty and danger are experienced in obtaining the release at the instant of the boat's coming in contact with the water, and the object of my invention is, that the hooks attaching the boats should be so formed that so soon as the weight of the boat is removed therefrom by contact with the water such hooks may be self-releasing. For this purpose, each hook or support is formed by two levers, one end of each of which is connected by a pin joint to the other, whilst the axes of motion of these levers diverge therefrom, and are the points of their suspension from two separate links, which hang from a ring common to both. The lower ends of these levers are bent into the form of a hook, and are capable of lying one across the other. When by a ring or otherwise a weight is applied to their hooked ends, and they are caused thus to cross each other, in that position they form a secure support; but so soon as the weight is relieved therefrom the tendency of these levers is by their form to open or separate at their hooked ends, and clear the ring or other attachment by which they held the weight. Supporting connections thus formed are applicable as self-acting releases when lowering merchandise, minerals, &c., and thereby save labour."

In the accompanying Plate, No. cxxxv., will be found two views of this invention, and is a view of Captain Talbot's hook in the position which it takes when a weight is attached to it; and Fig. 15 is a view of the hook after the weight has been released.

It should be understood that what have been known as slip shackles and slip hooks, very similar to the above described instrument, have been long known and used; the unsuitability of such an apparatus, whether this or any other of the self-releasing suspenders, for releasing ships' boats from the davits upon touching the water is well known, as they have proved most dangerous, and in some cases fatal, and therefore should never be applied.



THE WINANS STEAMER.

WE give herewith a correct picture of the famous Winans steamer, launched on the 6th of October, at Ferry Bay, Baltimore, by the Messrs. Winans, of that city, the designers and contractors. For those of our readers who have not heard of this vessel, we will observe that, if successful, she will inaugurate a new era in naval architecture. She is like nothing now afloat. She has no keel, no mast, no rigging, no deck, no cutwater, no blunt bow, no round or square stern. Round the middle runs a round ring, attached to which are flanges, set at the correct angle to strike the water and propel the vessel. The ring is made to revolve rapidly round the vessel by four powerful steam-engines placed amidships. The deck is only a segment of a circumference of 16 feet; upon it are riveted four settees, upon which passengers will take the air. There are rudders at both ends, in shape like spades, with a blade 4 ft. by 3 ft. The vessel is 16 ft. in diameter at the widest part, and 180 ft. long; and that her owners expect her to cross the Atlantic in four days.

The engines are high pressure, and have a cut-off that is variable from one-eighth to full-stroke; and, combined, will exert threefold more power in proportion to displacement of water than those of the most powerful steam-ships now built. The boilers are similar to locomotive boilers in plan and construction, and will consume about thirty tons of coal in twenty-four hours.

It has no keel, no cutwater, no blunt bow standing up above the water-line to receive blows from the heaving sea; no flat deck to hold, or bulwark to retain the water that a rough sea may cast upon the vessel.

The vessel, being built entirely of iron, will be free from all danger from fire; and, from the number of her distinct and watertight compartments, she will be comparatively free from danger of sinking in case of collision or other mishap, as any one or even several of the compartments might be filled with water without seriously endangering her safety. And further, the form of the vessel, while it makes her stronger than usual, is such as to afford the least possible hold for the wind and waves; so that the danger of injury from heavy seas and storms is small. For these reasons it is believed that the vessel will be an unusually safe one.

The fact that every portion of the hull or outer shell of the vessel is arched in all directions, and the entire material is in the best possible position and form to resist the various strains that it can be subjected to at sea, gives it an important advantage in point of strength, safety, and buoyancy, over any other seagoing vessel.

Want of space this month will not allow us to enter more fully respecting the above. We purpose referring to it again at some future time.

INSTITUTION OF ENGINEERS IN SCOTLAND.

SECOND SESSION.

THE first meeting took place on the 27th October, 1858, when Prof. W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S., President, delivered the following opening Address:—

GENTLEMEN,—When, at the first regular meeting of our first Session, almost exactly a year ago, I had the honour to deliver to you an introductory address on the nature and objects of our Institution, I ventured to indulge in anticipations of success, founded on the character of engineering industry and skill in this city, and in Scotland generally. I have now to congratulate you on the fact that those anticipations have not only been realised, but exceeded. The time of each of our meetings has been fully occupied by papers and discussions of great interest and practical value. Those papers and discussions, copiously illustrated by drawings, have been published in a volume which may be left to speak for itself. The number of our members has greatly increased, and goes on increasing at each successive meeting; and our financial position is perfectly satisfactory.

I shall now address to you some remarks on the present condition of the branches of practical science which we cultivate; on the extent to which, during the past year, they have been advanced, by our own labours and those of others; and on some of the many questions which they still present for solution. In so doing, I shall not have to enter into a detailed analysis of the papers read here last Session, or the discussions on them, seeing that they have been printed in the volume of Transactions which you possess, and that a summary of their subjects, prepared by our secretary, is contained in the Report, which has recently been distributed, of the Session now beginning.

The subject of decimal measures was brought before us by the papers of Mr. Neilson and Mr. Holland, and discussed at three meetings. With reference to Mr. Neilson's proposal, that the French system of measures should be adopted at once, and as a whole, I may remind you that doubts had been entertained whether so great and sweeping a change could easily be introduced amongst workmen, and that various members mentioned instances of the ready adoption by workmen of French measures, tending to remove that doubt. I am happy to be able now to refer to additional facts of the same character, tending to prove that amongst intelligent artizans (and no others are fit for engineering work), no difficulty whatsoever would be met with in the introduction of the metrical scale. I had recently the satisfaction, in common with other members of the British Association, of visiting the locomotive works of an eminent engineering firm at Leeds—Messrs. Kitson, Thompson, and Hewitson—and there we found several engines in progress for foreign railways. All those engines were made to French measures, of which the workmen, with the utmost willingness, had learned the use in a few minutes. It appears, in short, that the metrical system is being introduced by degrees into practice, without the aid either of legislation or of the action of societies. There is a close connection between the subject of standards of measure, and that of engineering tools. In connection with the latter subject, we had, last Session, only one paper; that of Mr. M'Onie on Mr. M'Cormick's screwing machine, illustrated by the machine itself. Papers on this branch of mechanics are much to be desired, and would prove both interesting and useful.

The papers by Mr. Morton and Mr. Lawrie, on the expansive working of steam, and the discussions on them, have tended to elucidate and to establish the principle, that in order to realise the economy properly due to expansion, means must be taken, by steam-jackets or otherwise, to prevent that condensation which always takes place in saturated steam when it performs work by expansion, without being supplied with heat from an external source. It is not that such condensation constitutes of itself a loss of power, but that the liquid water produced by that condensation, by its presence in the cylinder, acts as a conductor, diffuser, and equaliser of heat, and tends to cool the steam at the beginning and warm it at the end of the stroke, and thus to lower the initial pressure and injure the vacuum, to reduce the work of the engine below that which is properly due to the expansion, and to make it approximate to that of a full-pressure engine, working at some pressure intermediate between that of the admission and that of the exhaust. By the use of the steam-jacket, the condensation of a certain quantity of steam is not only prevented; but, instead of taking place in the cylinder, it is made to take place in the jacket, where the liquid water produced is not injurious. The liquefaction of a portion of the steam which performs work by expansion was deduced from the mechanical theory of heat in 1849. Prior to that time, the whole of the water found in the cylinders of engines without jackets was supposed to have been carried over from the boiler by priming.

I am happy to recognise in the papers and discussions to which I have referred, as well as in papers which have been read to other societies, or which have appeared in the mechanical journals, evidence that the true principles of the mechanical action of heat, founded on the idea that heat is not a substance, but a form of energy, are making their way amongst practical men, and are being usefully applied by them.

As a means of facilitating that progress, by putting the expression of those principles into a shape more familiar to practical engineers than their present form, it was recently suggested by Mr. Stephenson, that, instead of the unit of heat commonly employed in scientific treatises, viz., so much heat as one pound of water requires in order to raise its temperature by one degree, quantities of heat should be expressed in terms of an unit, which practical men oftener have occasion to think of; viz., so much heat as one pound of water at 212° of Fahrenheit requires, in order to convert it into steam at the same temperature; or what is commonly called, "the latent heat of one pound of steam at 212° of Fahrenheit;" being, in fact, the unit of heat now commonly employed in comparing the effects of different kinds of fuel, and different forms of furnace. This suggestion of Mr. Stephenson appears to be well worthy of consideration and discussion.

The following is a comparison of different units of quantity of heat, British

and French, reduced to their equivalents in units of mechanical energy, as a common standard of comparison based on the experiments of Joulc.

COMPARISON OF UNITS OF HEAT.

BRITISH UNITS.

	Equivalent energy in foot-pounds.
One degree of Fahrenheit's scale in a pound of water.....	772
One degree of the centigrade scale in a pound of water ...	1390
Latent heat of one pound of atmospheric steam..........	745750

FRENCH UNITS.

	Equivalent energy in kilogrammètres.
One degree of the centigrade scale in a kilogramme of water	423·7
Latent heat of one kilogramme of atmospheric steam	22730

One kilogrammètre = 7· 23314 foot-pounds.
Onc foot-pound = 0·138253 kilogrammètres.

Besides the proper management of the expansive working of steam, we have another means of improving the economy of power in the cylinder of the steam engine, by using steam heated to a temperature higher than the boiling point corresponding to its pressure, or as it is commonly called, "superheated steam." The efficiency of any engine moved by the mechanical action of heat in any fluid, is the greater, the greater the difference between the temperature at which the fluid performs its work and that at which it is either rejected or condensed, as the case may be; and the use of superheated steam enables us to work at a high temperature, without producing a dangerous pressure. Although the practical use of superheated steam has made considerable progress of late, there is still a scarcity of data for precise calculation on the subject; the only experiments on the laws of expansion of superheated steam being those of Mr. Siemens, which are of too limited extent.

The instances which practice has lately afforded of improvements in the economical working of steam, are so numerous, that it would be impossible, within reasonable limits, to give even a condensed view of them all; and if I now select one case as an example, it is simply because the economy in that case was ascertained by experiments conducted under my own inspection. It is that of the engines furnished by Messrs. Randolph and Elder to Mr. James R. Napier, for the steamer *Admiral*, which he lately built for a Russian company. The engineers guaranteed to the builder that the consumption of coal should not exceed 3 lb. per indicated H.P. per hour, and the actual consumption, as ascertained by me, was 2 $\frac{19}{20}$ lb.

The steamer which I have now mentioned is an example of progress in naval architectnre as regards the precision with which the power required to propel a ship of a given size and shape at a given speed can be computed beforehand; a point of the highest importance, both to the purchaser and to the builder. In the present instance, the builder, Mr. James R. Napier, in his contract with the purchasers, bound himself, under heavy penalties, to fulfil conditions as to draught of water, cargo, speed, power, and consumption of coal, which he could not possibly assure himself of fulfilling except by being able to compute beforehand the resistance and propelling power of the ship at any required speed, *from the drawing of her lines,* with very great precision: and in this he was perfectly successful.*

In such calculations as these, an error in excess is as fatal as an error in defect; for if, in order to make sure of fulfilling the contract as to speed, the engines are made too powerful, they become also too bulky and heavy, and the conditions as to cargo and consumption of fuel are violated. It is true that by the common method of calculation, that is, by making the indicated H.P. proportional to the square of the lineal dimensions multiplied by the cube of the speed, the power required by a proposed new ship may be computed with tolerable exactness, from the results of a previous experiment on an existing ship of similar, or nearly similar figure and proportions; but if no such experiment has been made or recorded, and especially if the proposed vessel has anything new and unusual in her proportions and shape, that method totally fails. It is to be hoped that a great body of useful experimental data on the subject of the propulsion of ships, whether by steam or by sails, will be collected by the committee appointed for that purpose by the British Association during their meeting at Leeds. It may be regarded as certain, that experiments on the resistance of models are almost worthless for the purpose of determining the propelling power required by ships of figures similar to those of the models. The forces which constitute the principal part of the resistance to the model and to the ship respectively, are of different kinds, and follow different laws: in short, to determine the laws of the resistance of real ships, we require experiments on real ships, and such are the experiments which the committee in question propose to collect and arrange.

I must not quit the subjects of ship-building and marine engineering without referring to the *Great Eastern;* and I am sure that all the members of this Institution will concur with me in regretting that that unparalleled work of Mr. Brunel and Mr. Scott Russell is still unfinished. Independently of her great size, the *Great Eastern* is a most beautiful example of good figure and proportions, and the finest specimen now existing of the application of the true principles of strength to naval construction. Her intended speed, I believe, has not yet been announced by authority; but with 11,000 indicated H.P., which is understood to be the intended power of her engines under ordinary circumstances, it will probably be between 15 and 16 knots when loaded, and may, of course, be increased by working the engines up to a higher power, and by the aid of sails.

It is gratifying to observe, that the improvement of propulsion on canals, which the sudden advancement of railways at one time caused to be neglected, is now employing much skill and ingenuity.

Mr. Robson and Mr. Milne gave this Institution last Session some interesting information as to steam propulsion on the Forth and Clyde canal, showing a good economic result. Recent experiments on the Aire and Calder navigation (as stated by Mr. Bartholomew to the British Association), have shown that by the use of steam tugs for the conveyance of minerals, the cost of locomotive power has been reduced to between one-tenth and one-twelfth of a penny per ton per mile—the usual cost of H.P. being one-eighth of a penny. It is still much to be desired that a practical trial should be made of Mr. Liddell's mode of propulsion on canals, to which I referred on a former occasion—viz., by means of fixed steam engines and endless wire ropes.

The subject of the use of steam-power in pumping water, to supply a town, or to drain mines, was brought before us by Mr. Mackain and Mr. Neilson, in connection more especially with the performance of direct-acting engines, in which a considerable saving of cost and resistance is effected by the comparative simplicity of the mechanism. The raising of solid material from mines has also engaged our attention, in connection with the application to mine-hoists of Mr. Robertson's frictional gearing.

The subject of mining in general is one of very great importance; and I think we have had fewer papers upon it than might reasonably have been expected in a locality where mining is carried on so extensively, and with so much success. I hope that this defect will be filled up in the present and future sessions.

I am sure that all the members of this Institution will rejoice at the recent opening of a field of ironstone in the outskirts of the city of Glasgow—an event which must contribute not only to the prosperity of this neighbourhood, but to that of the whole country. It is a remark not the less true for being commonplace, that coal and iron are the roots of the material greatness of Britain. At the recent meeting of the British Association, nothing gave greater satisfaction to the multitude assembled than the announcement by Professor Phillips that the lately-opened ironstone field of the north-east of Yorkshire is likely to last two thousand years.

Mr. Johnstone's description of a very simple and efficient joint-chair last Session, led to a discussion on the permanent way of railways—a subject that ought always to occupy much of our attention, especially when we can obtain the results of the practical use of different systems.

As regards railway carriages, the tendency of the present day is to increase their length and capacity in imitation of those used in America. Those large carriages are cheap and convenient; but it is worth consideration whether their length and weight do not increase the danger to passengers in the event of a collision; their weight, as increasing the momentum of each separate carriage; and their length, as diminishing the compressibility which the train derives from the buffer-springs. Much remains still to be done towards increasing the comfort of railway carriages, which is a matter not merely of ease, but of economy; for a passenger who arrives at the end of a long journey in a condition of fatigue from an uncomfortable carriage, is less able to attend to business than he ought to be, and sustains a loss of time, which is equivalent to a loss of money.

The interesting work of Mr. Colburn and Mr. Holley on European Railways, has furnished abundant evidence of the fact that the light and cheap mode of construction which is common in America, and which, from motives of economy in first cost, has been of late partially introduced into this country, not only fails to produce any real economy, but is absolutely ruinous in working expenses.

The manufacture of locomotive engines is making great progress, through improvements in rapidity and exactness of workmanship. The peculiarities of the American locomotives, which were last Session very fully explained to us by Mr. Neilson, are attracting attention in this country, from the good adaptation of those engines to steep gradients and sharp curves. The question of the balancing of locomotives was brought before us by Mr. Lawrie, and we received interesting information respecting it from Mr. Allen.

The use of coal instead of coke as fuel for locomotives is rapidly spreading, with most beneficial results. The advantage of coal over coke, in point of cheapness, is so well known as to need no comment; and many members of this Institution must have had occasion to observe the great superiority of coal over coke in raising and maintaining a high pressure of steam; the effect of which is, that the same engine which, with coal as fuel, can be worked expansively, so as to economise the heat to the best advantage, requires, when coke is used, to be worked at full pressure; so that even independently of the higher price of coke, the steam works less economically.

Several forms of locomotive fire-box, specially adapted for burning coal, have lately been invented. I have seen it burned in the ordinary fire-box without the production of any smoke whatsoever, the coal gas being entirely consumed before the flame entered the tubes; but this required careful adjustment of the opening of the fire-door on the part of the engine-driver and stoker, so as to admit just enough of air above the fuel and no more.

The prevention of smoke, besides its great natural importance, has of late acquired considerable artificial importance, by having been made the subject of a law. It is well known that the prevention of smoke is accomplished by producing a complete combustion of all the constituents of the fuel; that if this is done without admitting more air into the furnace than is necessary for complete combustion, it promotes economy of fuel; and that there are a great number of inventions, patented and unpatented, any one of which will accomplish that object if properly managed. The fundamental principle of all the successful inventions for preventing smoke is the same, viz., to introduce enough of air

*Displacement of the *Admiral*	820 tons.
Length	210 ft.
Breadth	32 ,,
Draft of water	$7\frac{1}{2}$,,
Midship section	214 sq. ft.
Speed	12 knots.
Indicated H.P., including friction	744
Coal burned per hour	2206 lbs.

above the fuel to burn the coal-gas, and enough of air below to burn the fixed carbon, or coke. The number of those inventions has become so great, that I cannot attempt to enumerate or arrange them; but it may be interesting to the members of this Institution to hear, that one of the most convenient and useful of these contrivances, the introduction of air through tubes perforated with small holes, near and behind the bridge, was successfully used forty years ago at Govan, by Mr. Morris Pollok.

The most perfect example of the prevention of smoke which I have lately seen, is at some reverberatory furnaces into which blasts of air are blown by a fan, both above and below the fuel. Before this system was adopted, those furnaces produced smoke almost unequalled for thickness, blackness, and volume; and now there is no smoke whatsoever emitted at any time, and there is a great saving of fuel. The blasts are regulated at the discretion of the workmen who attend to the furnaces. By stopping the upper blast, volumes of black smoke in the old style can be reproduced at any moment; but the re-admission of the blast instantly converts that smoke into flame.

In the administration of the law for the prevention of smoke, the thing chiefly to be avoided is, the giving a preference to some particular method of prevention, and the enforcing it in all cases, without considering whether it is suitable to each particular case. Considering how many different contrivances are available, every furnace-owner ought to be left as far as possible to adopt that contrivance which appears to his own judgment to be the most convenient and suitable. It is not a grievance, that the owners of boiler furnaces, and furnaces of a few other classes, should be prevented from making smoke, if there are parties to whom smoke is a nuisance; but it is a grievance that any particular method of preventing smoke should be forced upon them.

The same principle is true with respect to the application of the law to all branches of practical mechanics. Let every engineer, every manufacturer, every shipowner, every person who makes or uses anything which can cause nuisance, damage, or danger to others, be fully responsible for all the nuisance, damage, and danger that his structures or machines may occasion; but let the means of preventing those evils be left to his own judgment. Any other course lessens his feeling of responsibility, and tends not only to retard the progress of improvement, but to produce the very evils which it is designed to prevent; and such is the effect of all regulation by authority of such matters as the thickness of a boiler, the thickness of the plates of a ship, or the construction of her frame.

Nothing can tend more effectually to prevent vexatious interference of the legislature with engineering and manufactures, than the belief on the part of the nation that the engineers and manufacturers are willing and ready to exert themselves, in order to render their works free from annoyance and danger to the public. That belief ought to be strengthened, and I have no doubt is strengthened, by the fact of the existence of such voluntary associations for promoting safety and economy in the use of steam, as that which has for three years been successfully in operation in and near Manchester, and that which is now being founded in Glasgow. Independently of their advantages in promoting safety, such associations are of most essential service to engineers, by collecting, recording and arranging facts as to the efficiency and economy of furnaces and engines; which facts, in their isolated condition, are of little or no value, but, being collected and arranged, lead to useful practical and scientific conclusions.

A contribution of almost unequalled importance has lately been made to our knowledge of the laws of the strength of boilers, by Mr. Fairbairn's experiments on the resistance of thin tubes to collapse. In my introductory address last year, I referred to a preliminary report on those experiments, which had been read to the British Association in Dublin. Since the close of our last Session, the detailed account of those experiments has been laid before the Royal Society, and will probably be published in the "Philosophical Transactions for 1858;" and an Abstract of their results has been read to the British Association. Mr. Fairbairn finds, that the intensity of the pressure required to make a flue or other thin tube collapse, is directly as the square of the thickness nearly, inversely as the diameter, and inversely as the length. The diminution of the strength of a flue, as the length increases, is a law never before suspected. For computing the pressure in pounds on the square inch, which makes a wrought-iron flue collapse, the following rule is sufficiently near the truth for practical purposes:—*Multiply the constant factor*, 806,000, *by the square of the thickness in inches, and divide by the product of the length in feet, and diameter in inches.* It is of great importance to strength that the flue should be exactly cylindrical; and as a flue with lapped joints cannot be exactly cylindrical, Mr. Fairbairn recommends that flues should be made with butt-joints and covering-strips.

Upon applying the law thus discovered to the internal flues of existing boilers, it appears that they are almost all too weak, being in general only one-third of the strength of the outer shell, instead of being equally strong, as they ought to be. This explains much of the mystery which formerly hung over the cause of steam-boiler explosions. So far from the number of such explosions being a matter for wonder, the marvel is, that any boilers with internal flues have escaped. As a remedy for that weakness, Mr. Fairbairn proposes to strengthen long flues at intervals, by means of hoops or rings of T-iron, his experiments having proved that a long flue so hooped is as strong as a shorter flue, whose length is equal to the distance between two adjacent rings. This strengthening of flues by means of rings is not absolutely new in practice; but the principles on which it depends, and the rules according to which it ought to be executed, are undoubtedly the discovery of Mr. Fairbairn.

I may now call your attention to an obvious limitation of the exactness of Mr. Fairbairn's formula. It cannot be true, that by indefinitely lengthening a tube, its resistance to collapse is indefinitely diminished; neither can it be true, that by indefinitely shortening a tube, its resistance to collapse is indefinitely increased. Mr. Fairbairn's formula, therefore, cannot be applicable to tubes which are either very long or very short, as compared with their thickness; although, for such intermediate lengths as occur in boiler-flues, it is sensibly quite accurate.

Another important experimental inquiry into the laws of the strength of materials, is that of Mr. William Henry Barlow, on the resistance of beams to breaking across. I mentioned in my introductory address last year, the general nature of the result of Mr. Barlow's first series of experiments; and I have now only to state, that his second series of experiments on the same subject has appeared in the "Philosophical Transactions for 1857." In the same volume also is contained an important series of experiments by M. Hodgkinson, on the strength of pillars.

Important progress has of late been made, in the adoption by practical men of correct principles as to the action of the particles of a beam in resisting fracture; the knowledge of which principles had formerly been confined to a few mathematicians. They relate chiefly to the action of the *shearing force*, and its combination with that of the *bending force*, which latter was at one time the only circumstance considered. One of their results is, that the *neutral axis* of a beam, as it is called, is not, as it used to be described, a place of no strain whatsoever on the particles; but is truly a place where, although the strain in a horizontal direction due to the bending force is nothing, the strain due to the shearing force is a maximum, and consists in a tension in one diagonal direction and a compression in another, each making an angle of 45° with the horizon. Mr. Stephenson lately, while referring to this fact, proposed a very ingenious method of verifying it experimentally. On the side of an unloaded beam, a series of small circles are to be drawn. When the beam is loaded, each of those circles will become an ellipse, whose dimensions are to be measured. It will be found, that near the upper side of the beam, each ellipse has its longer axis vertical and its shorter axis horizontal; that near the lower side, each ellipse has its shorter axis vertical, and its longer axis horizontal; that at the neutral axis, each ellipse has its longer and shorter axes sloping at angles of 45°, and that ellipses in intermediate positions have intermediate figures and obliquities.

The construction of iron-bridges of great size still continues to be one of the leading features of the engineering of the time. The forms of bridge which have been practically tested, may be divided into five classes—the arch, the suspension bridge, the tubular girder, the lattice girder, and the bowstring girder—of each of which I shall cite one recent example:—the arch, exemplified by Mr. Page's Westminster bridge, which has the broadest roadway in the world; the suspension bridge, by the bridge of the same engineer at Chelsea; the tubular girder, by Mr. Stephenson's enormous viaduct across the St. Lawrence at Montreal; the lattice girder, exemplified in the form invented by Captain Warren, by the Crumlin viaduct, which, constructed by Messrs. Liddell and Gordon as engineers, and Mr. Kennard, as contractor, crosses the vale of the Taff at the height of 220 ft.; and the bowstring girder, exemplified in a novel and singular form, and on a gigantic scale, by Mr. Brunel's viaduct at Saltash, in which the string of the bow, which in the original form of the bowstring girder was a straight tie, is made to take a curved, or rather a polygon, form, and to act as a suspension chain. The great works which I have cited as recent examples of viaducts, are interesting in other respects besides the superstructure. The piers of the Crumlin viaduct, which I understand to have been designed by Mr. Kennard, consist of a skeleton framework of iron, being excellently adapted to the purpose of attaining an immense height at a moderate expense. The bases of the piers of the new Westminster bridge may be briefly described as consisting mainly of cast-iron boxes filled with concrete. Those of the Victoria bridge at Montreal are of massive granite masonry, remarkable for the cost which has been incurred in order to enable the piers to withstand the floating ice of the river. The central pier of the Saltash viaduct is founded by a process originally practised at the new Rochester bridge, but never before carried out on so great a scale, consisting in the sinking of vertical iron cylinders filled with compressed air, inside of which the excavators and mason work.

The completion of those great structures will furnish important data for settling the question as to the most economic mode of crossing wide valleys at great heights, and of founding heavy structures under difficulties of various kinds.

A sixth class of bridge, which I mention apart, because it has not yet been practically tested, its probable success having been inferred from theoretical calculations, verified by experiments on a reduced scale, is the suspension bridge, adapted to the passage of railway trains by a stiffening framework, of dimensions greater than those hitherto employed, and sufficient to make the bridge as stiff as a tubular or a lattice bridge of the same strength. This is the design of Mr. P. W. Barlow's bridge at Londonderry, to which I referred in my address last year. Should that bridge answer its purpose of safely carrying trains at considerable speed, it will probably be found to be the cheapest mode of crossing spans which lie between certain limits.

A very happy adaptation of the suspension bridge is its use to carry canals. When used for that purpose, the suspension bridge requires no stiffening framework, and is subject to no undulations, except such as may be caused by the wind; for as each boat displaces its own weight of water, the load is always uniformly distributed. This invention of Mr. Roebling has been employed with success in America, but has not yet been introduced into Britain. It is probable that it might be found an easy and cheap method of carrying aqueducts for the supply of towns, or of watermills, across deep valleys.

In connection with the storing and conveyance of water for such purposes, I shall now refer to an important improvement in the gauging of the flow of streams of water by means of weirs or "notch-boards," which has recently been introduced by Professor James Thomson, of Belfast. Hitherto it has been the practice to gauge such streams by causing them to flow through rectangular notches in vertical boards or weirs, and observing the height at which the still water behind the weir stands above the lower edge of the notch. The mean velocity of the stream of water which falls over that edge in the form of a cascade, bears a certain proportion to the velocity which a heavy body

would acquire by falling through the height already mentioned. The sectional area of the same stream is found by multiplying the product of the same height and of the breadth of the notch, by a factor called the "coefficient of contraction." The product of the mean velocity of the stream into its sectional area gives the volume of water discharged in a second.

A serious imperfection in this method consists in the uncertainty and variability of the "coefficient of contraction," which is different for different heights, and also for every different proportion of the height to the breadth of the notch, and is consequently variable for the same stream flowing through the same notch, when the volume of the flow varies. Its variation has not been reduced to any general law; and the value to be assigned to it in each particular case has to be taken from voluminous tables of experiments by Poncelet and Lesbros. Engineers are consequently often compelled, sometimes by the want of those tables and sometimes by want of time for their use, to employ an approximate average coefficient of contraction, and thus to compute the flow from sources of water in a rough and inaccurate way.

This evil obviously arises mainly from the fact, that the section of the stream flowing through a rectangular notch is not a similar figure when the flow is large and when it is small; and Mr. Thomson has therefore adopted a form of notch in which the section of the stream is always of similar figure; that is to say, a triangle with the apex turned downwards. For such a notch, the coefficient of contraction is either constant, or very nearly so.

Mr. Thomson's experiments, which are made at the expense of the British Association, are not yet complete; but they are sufficiently advanced to have enabled him to publish a formula applicable to cases in which the velocity of the stream in the pond behind the weir is insensible. The great utility of that formula induces me to state it now, though in terms differing a little from those in which Mr. Thomson has expressed it.

For the mean velocity of the stream, take eight-fifteenths of the velocity due to the height of fall from the surface of the pond to the apex of the notch. For the area of the contracted stream, take five-eighths of the area of the triangle bounded by the top-water level and the edges of the notch. In other words, the volume of the flow is the area of that triangle, multiplied by one-third of the velocity due to the height before mentioned.

Mr. Thomson's improvement in the measurement of sources of water comes at a good time; for the economic use of these sources is becoming every day of greater importance. The subject of the water supply of large towns has of late been so fully discussed that I shall not now enlarge upon it, especially as we may, perhaps, hope at a future period to have it before us in a most interesting shape, when the works now in progress for the supply of Glasgow shall be completed. Another important and very ancient use of sources of water is for the obtaining of motive power; and that is a use which no degree of abundance or cheapness of coal ought to induce us to neglect; for every H.P. obtained on land by the proper application of streams of water, sets free a certain quantity of coal to be employed at sea or in locomotive engines. It is well known that when rivers are left in their natural condition, their flow is so irregular, from the alternation of floods and droughts, that a small fraction only, such as a third or a fourth of the whole volume of water which flows down, can be made available for water-power. The remainder, being the surplus water which comes down during floods, usually does much damage, and effects no useful purpose except sweeping away deposits in an uncertain manner and at irregular intervals. The remedy for that evil is the well-known and obvious one of forming store reservoirs in suitable sites on the course of each stream, in order to store up the surplus waters of floods, and to let them down by degrees so as to increase the ordinary flow available for motive power and other useful purposes.

That remedy has been extensively applied to small streams, such as the Allander and the White Cart in this neighbourhood, the Shaws water near Greenock, and others; but the larger rivers are left nearly, if not altogether, in their natural irregular condition. It was long ago pointed out by Mr. Adam, that the valley of the Clyde, above the Falls, presents a site where a large quantity of water could be stored at a moderate cost, to be used for motive-power and other purposes. A similar scheme was, at a later period, proposed by Mr. Thomas Kyle, for the water-supply of Glasgow; and a few weeks ago, Mr. Hill, of Barlanerk, proposed its revival, with a view more especially to the use which might be made of the water-power so obtained for the removal of sewerage.

There can be little doubt that the storing and equalizing, to a certain extent, of the flow of the Clyde might be rendered remunerative; for, if the probable demand for the additional water-power which would be rendered available were first ascertained, the magnitude of the storage works could be adjusted to that demand. With respect to the sewerage of Glasgow, there is one benefit which would obviously arise from a partial equalizing of the flow of the Clyde, even under the present system of drainage. It appears from the experiments reported by Dr. Anderson and Mr. Bateman, that sewerage which flows into the Clyde at Glasgow, when the river is low, takes a month to reach Dumbarton; so that it travels at the rate of about half a mile a day. Were the flood-waters of the Clyde stored, even to a moderate extent, and let out by degrees, the fresh-water current would never fall to that extreme sluggishness which has been proved by those experiments, and the sewerage could be carried away with a greatly increased velocity.

I have now been led by degrees to the most perplexing problem ever submitted to engineers—that of the drainage of large towns; complicated as it is with chemical, physiological, agricultural, commercial, and social questions; of which almost all that can be said is, that if much labour and thought have been expended on them, much more are still required. The opinion of many competent judges appears to be, that if physical circumstances were to be alone considered, the best method for the cleansing of cities would be to remove as much of their refuse as possible in the solid form, combined with dry deodorizing substances; but against that plan there has been urged the objection, in a social point of view, that the change of customs which its adoption would involve is impracticable in Britain. If, then, the refuse of cities is to be removed altogether in the form of liquid sewerage, any means of rendering that sewerage harmless, at a moderate cost, whether it is to be discharged into the sea or into a river, or used for the irrigation of land, must be most valuable. According to the report of Dr. Anderson and Mr. Bateman, such means are afforded by an invention of Dr. Angus Smith and Mr. M'Dougall, consisting in the addition of sulphurous acid and carbolic acid to the liquid sewerage. The use of certain substances distilled from coal for that purpose, was some time ago proposed by Mr. John Tennent, manager of St. Rollox Chemical Works. It would be foreign to the province of this Institution to enter into chemical questions in detail. The mechanical branch of the subject will probably be soon brought before us again.

From sanitary engineering the transition is natural to the art of defence against human enemies, of which we had an example last Session in the improved rifle-sight of Mr. Lawrie. Many experiments on that art are in progress in different parts of the world, especially on artillery and the strengthening of ships. The most curious contrivance in the art of war which has recently been published is that of Mr. Mackintosh, for suffocating an enemy by the smoke of naphtha and sulphuret of carbon.

In harbour and dock engineering, the limited time now remaining only permits me to refer to those excellent examples which exist in our immediate neighbourhood, and to hope that the engineers of those works may be induced to give a description of them to this Institution.

The last subject to which I shall refer is that of submarine telegraphs. With respect to the Atlantic telegraph, it must be admitted that even in the event of its being found impossible to repair the fault in the existing cable, the experiment which has been made will have answered the purpose of proving the practicability of the undertaking, and of furnishing its promoters with that experimental knowledge of its difficulties and dangers which will enable them afterwards to avoid or overcome those obstacles, so as to insure the permanent efficiency of the next cable that shall be laid. The great improvements lately made by Professor William Thomson in apparatus for transmitting and receiving electric signals, will much facilitate the use of all telegraphic lines of great length; having in fact enabled intelligible messages to be sent through the Atlantic cable, when other means had failed. The Red Sea cable will probably be laid with the success which has hitherto attended the operations of Messrs. Newall and Co. There will soon be a submarine telegraph across Bass's Straits, to connect Australia with Tasmania.

Thus far I have endeavoured to fulfil one of the duties of the President of this Institution, by giving an outline of the recent progress and present state of some at least of the many branches of the vast subject of engineering and mechanics. In conclusion, I again congratulate the members of this Institution on the extent to which it has contributed to that progress, and on the prospect which it enjoys of continuing that good work with success and honour.

The Secretary (Mr. Hunt) read the Report of the Council, showing the progress and financial condition of the Institution to be very satisfactory.

The Secretary then read a Paper "On a Centrifugal Pump, with Exterior Whirlpool, constructed for Draining Land;" by Professor James Thomson, of Belfast.

The thanks of the meeting were voted to the President for his Address, and to Professor Thomson for his Paper.

ON THE EXPANSION OF STEAM IN STEAM-ENGINES.

(Continued from page 274.)

The results before stated are expressed without difficulty in the exact language of algebraic notation; but to do so is inappropriate in a Paper of this character, and the subject has already been investigated analytically in an elaborate and philosophical manner by those whom Mr. Joule calls our illustrious townsmen, Professors Rankine and Thomson.

These eminent authors show that the power which can be obtained from a given weight of steam is not infinite, nor even enormously large, as would be the case if the hypothesis formerly assumed from the law of volume be true; but that it is limited to the number of H.P. contained in the heat of which the steam is deprived, reckoning a H.P. of 33,000 lbs. 1 ft. high, equal to a quantity of heat which would raise the temperature of 1 lb. of water $42\frac{1}{3}$ degrees. They show that the heat of which the steam can be deprived so as to produce power cannot, or rather has not in any case much exceeded one-sixth of the whole heat which it receives from the fire. They show further that, except in cases in which expansion has been largely and judiciously employed, this limit of power, equivalent to about one-sixth of the whole heat received from the fire, has not been approached, and cannot in any other way be approached.

The spaces shaded with vertical lines in the diagrams 6 and 7, show the pressure of the steam at the several parts of the stroke, on the supposition that the steam receives no heat from and gives no heat to the material of the cylinder; but in every working engine the steam, as it cools down in temperature by expansion, receives heat from the cylinder, which again, during the early part of the following stroke, receives heat from the steam. Thus, when the cylinder is not provided with a steam-jacket, the two-fold operation takes place of the material of the cylinder

receiving heat during the early part of the stroke, which it transfers to the steam during the latter part of the stroke. If, in this twofold operation, the cylinder delivers up to the steam, with sufficient rapidity, during the latter part of the stroke, all the heat which it received during the early part of the stroke, no loss or gain is occasioned in the indicated power of the steam; but if less than the whole heat is delivered up, a loss arises to the extent of the difference; or if it be delivered up with insufficient rapidity, which there is reason to believe is the fact, a loss is occasioned to some amount.

The principles now explained afford a ready solution of the utility of the steam-jacket, an appendage which, though it has always been found highly useful in practice, has nearly, with the same uniformity, been pronounced useless by writers on the steam-engine. In the steam-cylinder, water is produced principally from three causes:—

1st. By being carried in suspension in the steam from the boiler.
2nd. By condensation of the steam in the development of power.
3rd. By condensation of the steam in heating the material of the cylinder, from the temperature to which it had been reduced in the previous stroke.

Each of these causes produces a considerable quantity of water, which, when the cylinder is unjacketed, is passed, together with the heat it contains, to the condenser; while in a jacketed cylinder, the water is produced, not in the cylinder, but in the jacket, and being passed, not to the condenser, but to the boiler, is economised. Even the heat contained in the water due to the first of the above causes is economised when a steam-jacket is employed, because, during the expansion part of the stroke, the water carried in suspension is converted into steam.

In practice, engines are constructed to work expansively in two ways. In one, two cylinders are employed, the steam from the boiler entering a small cylinder, where it is partially expanded, and passing to another of larger dimensions, where it is expanded to the limit intended. In the other way, one cylinder only is employed, in which the steam is admitted during a portion of the stroke, and expanded during the remainder. In the engine constructed with two cylinders, the quantity of steam used per stroke of the engine is measured by the volume of the second or large cylinder added to the amount utilised due to the power developed: and in the engine constructed with one steam cylinder, the steam used per stroke for the same amount of expansion is the volume of the cylinder added in like manner to the amount due to the power developed. Therefore, on comparing the modes of expanding by the one plan and by the other, the comparison falls to be made between an engine having two cylinders and an engine having one only, in which engines the large cylinder of the one is of the same volume as the single cylinder of the other.

So far as my information goes, more minute and accurate experiments made with engines having only one cylinder are on record, than are those made with engines having two cylinders. Indeed, I am not aware of any prominent experiments made to ascertain the consumption of fuel of engines having two cylinders being on record. In Lancashire, the association formed for the prevention of boiler explosions and the economy of steam, furnishes periodically a mass of information of great utility; but although that information establishes the fact, that a high rate of economy is obtained by engines constructed in either way, yet, as the consumption of fuel by each of the 600 engines on the list of the association is blended with the consumption necessary to heat buildings, or to perform other operations, no exact information is obtained from the reports, neither of the consumption of any individual engine, nor of any relative consumption of different engines, sufficient for a safe comparison.

The best engines on the list of this Association, both double and single cylinder engines, have a consumption of fuel of 3·1 lbs. per indicated H.P. of 33,000 lbs.; but that consumption, including what is due to other operations besides that of the engines, furnishes no exact information beyond the fact that the consumption of the engines alone must be small.

The diagrams, Figs. 8 and 9, were made by the engines called *Lion* and *Lioness*, the property of the New River Waterworks, London, and constructed at Soho by Messrs. James Watt and Co. With these engines most accurate experiments have been made, in some of which the duty ranged as high as 107,000,000 lbs. 1 ft. high per 112 lbs. of coal; and in one. extending over a period of ten months, the duty of 112 lbs. of coal was in excess of 90,000,000 lbs. 1 ft. high, being a result equal to 2·46 lbs. per H.P. of 33,000 lbs. 1 ft. high over and above the resistance due to the working of the engine. In contrasting the effect of fuel as measured in the steam-cylinder from the diagram, and as measured by the ultimate effect of the engine, in delivering water over a stand pipe, for example, the one result falls to be reduced by the resistances of the engine, whilst the other is clear of all deductions. Hence the result in the instance of the *Lion* and *Lioness* engines, which was measured by the delivery of water over a stand pipe, is a consumption of fuel per indicated H.P., measured in the cylinder, of $\frac{33000}{44000} \times 2{\cdot}46$ lbs. = 1·845 lbs.

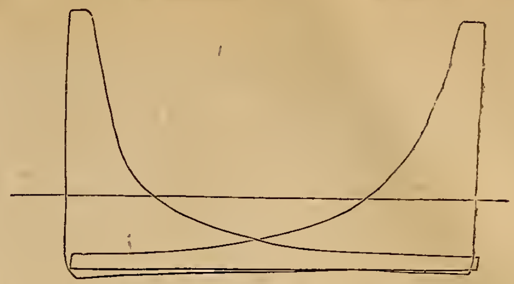


Fig. 8.—" Lion " Engine.—Top of cylinder av. 11·46 lbs.; bottom av. 10·58 lbs.

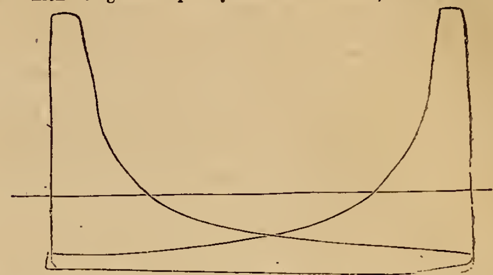


Fig. 9.—" Lioness " Engine.—Top of cylinder av. 10·38 lbs.; bottom av. 10·9. lbs.

I am not acquainted with any experiments made with any other engine of any construction which show a result equal to this of the *Lion* and *Lioness*, taking into account the duration of the experiment.*

But whether the results obtained with the *Lion* and *Lioness* be surpassed or not by any other engines of either the double or single-cylinder arrangement, the comparative excellence of the two arrangements is not by that single fact decided. There are other elements, not elicited in the experiments with these engines, that fall to be taken into account. Against the single-cylinder arrangement it has been contended that, as the power of the engine becomes large, either by an increased diameter of the cylinder, or by an increased pressure of the steam, a shock is incurred at the commencement of each stroke that is destructive to the smooth working of the engine; and it has also been contended that the double-cylinder arrangement, by dividing the power between two cylinders, diminishes the gross weight of the machine and the cost of construction. The first of these objections to the single-cylinder arrangement is by no means a new one, having been urged in the history of the steam-engine against each increase made to the diameter of the cylinder, and each increase in the pressure of the steam; yet locomotives, having cylinders of a diameter increased from 12 in. to 20 in., run at speeds increased from 20 to 60 miles an hour without shock of any kind; and marine engines, with cylinders of gradually increased diameter, worked by steam of gradually increased pressure, move without halt at a speed of 400 ft. to 500 ft. per minute. In the steam-ship *Australasian*, recently built by Messrs. J. and G. Thomson, of Glasgow, the engines, which have cylinders 96 in. in diameter, turn the centre with the utmost smoothness when worked with steam of 20 lbs., and moving at 400 ft. per minute. The cylinders of this ship being 96 in. diameter, and the steam 20 lbs., the effect is the same as that of cylinders of 68 in., with steam of 55 lbs., or as that of cylinders of 48 in. with steam of 125 lbs. The criterion, therefore, of the engines of the *Australasian*

* A series of diagrams were exhibited at the reading of this Paper, which were made by engines having an expansion-valve arranged on the Author's plan, and capable of working with the utmost accuracy.

These diagrams showed the action of the steam when supplied to the cylinder during different portions of the stroke, varying by an inch from $3\frac{1}{4}$ in. to 12 in. in a stroke of 31 in., and an examination of them discloses the exceedingly remarkable fact, that in those diagrams in which expansion was not carried far, the final pressure of the steam was considerably less than the gaseous laws of expansion would assign; while in the diagrams in which expansion was carried farthest, the final pressure was considerably greater than the gaseous laws would assign. In the several diagrams the final pressure was marked as given by a measurement of the diagrams, and also the pressure assigned by the gaseous laws of expansion. In these pressures a regular gradation of differences exists, and this remarkable fact plainly indicates the operation of an important influence, exercised partly by the alternate heating and cooling of the cylinder, and partly by the water suspended mechanically in the steam. This influence it is impossible to measure with precision, in any calculations of diagrams, to ascertain the consumption of steam or fuel due to these diagrams: and on that account chiefly I am of opinion that diagrams do not, in any instance, supply available information for an accurate measurement of the steam used.

In the calculation of the quantity of steam used in the series of diagrams, the part of it which was condensed in the development of the power, as defined by Joule's law, was separated from the part of it which passed to the condenser in the form of steam; and it appears that when the engine was working with steam throughout the stroke, this quantity amounted to about $5\frac{1}{2}$ per cent. of the gross quantity used; and when the steam was cut off at $3\frac{1}{4}$ in. from the commencement of the stroke, the quantity which was condensed amounted to about 14 per cent. of the whole.

is a sufficient reply to the objection of shock, until engines of greatly increased power become necessary.

But the practice of all engineers, with engines of moderate dimensions, is alone sufficient to establish the fact, independently of reference to such engines as those of the *Australasian*, that, provided the engines be of the requisite strength—without which no machine can operate satisfactorily—the severity of the shock depends not on the weight of moving mass, nor on the pressure of the steam, nor in any degree upon the length of the stroke of the engine, but upon the manner in which the steam is cushioned in the returning stroke. When that cushioning is adjusted so as to bring up the pressnre of the inclosed steam to an amonnt approaching that of the steam in the boiler, by the time the valve opens for the admission of fresh steam, no shock occurs, nor can occur. The second objection urged against the single-cylinder arrangement, of being more expensive and heavier than the double-cylinder kind, is not so capable of precise argument, because, after any comparison that could be made of the weight and cost, the question would still, to a considerable extent, remain a matter of opinion, whether the weights and costs were calculated of the correct amounts. When it is considered, however, that for the same amount of expansion the large cylinder alone of the double-cylinder arrangement, is equal in volume to the single cylinder of the other kind, there is obviously a considerable margin in the small cylinder and appendages of the double-cylinder arrangement, to apply in the additional strength necessary for the single cylinder of the other kind. Another advantage in favour of the double cylinder has been urged in a supposed more uniform development of power; but, although that advantage does exist when single engines are employed, it does not exist when two engines at right angles are employed.

Having stated the chief argnments advanced in favour of combined cylinder engines, it now becomes desirable to consider what has beeu or may be advauced on the other side.

1st. It is contended by those in favour of single-cylinder engines that they are of a lighter and cheaper construction.

2nd. That they have smaller surfaces to clothe, in order to prevent radiation, and to encase in a steam-jacket.

3rd. That the alternate heating and cooling of the cylinder, which takes place more or less when steam is used expansively, exists to a less extent and is spread over a smaller surface in the single than in the double-cylinder arrangement.

4th. That there is less friction, a smaller consumption of stores, and that considerably less attention is necessary with one cylinder that with two.

In drawing an inference from these arguments, Mr. Joule comes to our aid by informing us, that if the steam in the different arrangements is passed to the condenser at the same temperature, no difference in the indicated power derived exists, whether the expansion has taken place in one or iu twenty cylinders; and therefore the minor, or rather secondary elements of the qnestion alone remain to guide the engineer to a selection.

In a consideration of the expansion of steam, it would be improper to omit a notice of certain statements made last session in the Institution of Civil Engineers in London. It was stated, during a discnssion of a Paper by Mr. Armstrong "On High Speed Navigation," that a record of the performances, for three or four years, of H.M. paddle-wheel steam-ship *Fury*, of 515 H.P., showed that, whilst working full power, 50 tons of coal were consumed per day of twenty-four hours, or 4·27 lbs. per H.P. per hour. When working at the first grade of expansion, 40 tons of coal were consumed per day, or 4·65 lbs. per H.P. per hour; and when working at the seventh grade of expansion, 15 tons of coal were consumed per day, or 12·3 lbs. per H.P. per hour. Similar results were stated to have occurred in the *Desperate*, *Terrible*, and other vessels, and an opinion was expressed that in marine engines the attempts hitherto made to comply with the conditions necessary for realising the benefits to be derived from working expansively had not been attended with adequate success. The loss when working expansively was believed to arise in a great measure from the condensation, by means of the extended snrfaces through which the steam passed, as only indifferent means were adopted for keeping up the temperature, and in that way there must necessarily have been a loss of mechanical effect.

Without knowing the details of the experiments referred to in these statements, it is impossible to account satisfactorily for the resnlts obtained, nor to say whether they can be accounted for by the loss alone arising from the increased radiation of the extended surfaces; but no one who has witnessed the effect produced on judiciously-constrncted engines by an increase in the steam cover of a valve, or who has travelled in a steamer in which the boilers are short of steam, and noticed the result of putting the expansion valve in action, or who has stood on a locomotive engine and tried the effect of modifying the action of the valve by the link motion, need be told that a better effect is not derived from steam worked expansively, even though, by an imperfect manner of applying the principle, the benefit can be dissipated. The effects of expansion which occur iu the instances I have quoted are manifest; and although they are not absolnte demonstrations of the benefit of expansion alone, in consequence of the steam being used at a higher temperature when the pressure is increased, yet they furnish the data of demonstrations which are conclusive. It is to be regretted that the details of the experiments made in these Government steamers have not been published; because, while they remain unexplained and not understood, they are calculated to produce an impression with regard to the use of steam which is injnrious to the progress of economy.

Allied to the subject of expanding steam is the problem of obtaining steam. The steam upon which scientific experiments are usually made is raised slowly, and contains only the water of saturation, which is in chemical combination; but the steam with which engines are worked is raised in all the hurry inseparable from the small evaporating surface in a boiler, and contains considerable quantities of water in mechanical suspension, in addition to that in chemical combination. This water contains more than double the quantity of heat which the same bulk of 20 lbs. steam contains, and as it carries nearly the whole of that heat to the condenser, it causes first a large loss of heat, and also a further loss of power by burdening the condenser and air-pnmp.

In some vessels, means have recently been employed to superheat a part of the steam used, and a most satisfactory economy is reported to have been derived in every instance. There is no reason to doubt that this economy has been obtained. By converting the water which the steam contains into steam, an improvement must unavoidably be derived; and by superheating the whole mass, so as that it will continne uncondensed or unreduced to water, when its temperature is lowered during expansion, a further and considerable advantage will also be derived.

The idea of superheating steam is not by any means a new one, but its introduction has been materially retarded by a desire to superheat to an extravagant extent, which was and still is so difficnlt as to be practically inconvenient.

There does not appear, however, any difficulty in superheating to such an extent as to utilize all the water in the steam, and to prevent coudensation during expansion.

The greatest improvement of which the steam-engine is, I believe, at present susceptible, is a judicious use of moderately-superheated steam in combination with expansion in a single-cylinder engine. In the marine engine and in the locomotive these desiderata can be carried out with facility, and in both economy of fuel is of the utmost importance.*

ON A JOINT-CHAIR FOR RAILWAYS.

By Mr. William Johnstone.

Illustrated by Plate cxxxv.

The object of the present Paper is to bring under the notice of the Institution a joint-chair recently adopted by the writer in constructing the permanent way on new lines of railway, and also on old ones requiring to be laid with new material.

The ordinary plan of joining the rails is to secnre the two ends of the bars in a joint-chair, by means of a wooden key.

The new chair is made to fit the section of the rail, leaving it only as much play as will allow it to slip on, and it consequently requires no key. All the intermediate chairs are made so as to receive the ordinary key for fastening the rail in its place. The sleepers on which the chairs are fastened are placed at equal distances of 3 ft. 8 in. from each other, excepting those next the joint, which are each 2 ft. 6 in. apart.

The advantages gained by this kind of chair are:—

1st. Security against accident, since the rails cannot get displaced at their joinings, as in the old plan, where the safety of the train passing along depended on the key at the joint being in its place.

2nd. Simplicity of application to either new or old roads.

3rd. The rednction in expense attending both its first application and its future maintenance.

Where railways are constrncted upon the old plan of having the joints secured by keys, the surfacemen of the railway require to make morning and evening examination of the rails, and sometimes oftener, principally

* Formerly, the water produced in the steam-cylinder was considered dne principally to radiation, and to some considerable but undefined change in the specific heat of the steam during expansion. The experiments of Regnault, however, informs us that there is no change in the specific heat of the steam, of any moment, in considering the source of this water; while the experiments of Mr. Joule point out its true source. But it is remarkable that both Professors Thomson and Rankine, instead of eradicating the notion of a change in the specific heat of steam during expansion, adopt it. Professor Thomson, in a Paper read before the Royal Society of Edinburgh, explains that, in his opinion, the quantity of heat necessary to evaporate a given weight of water is not constant, bnt may be infinitely varied, and lauds Professor Rankine for his discovery of "negative specific heat."

Specific heat, however, is essentially a relative measurement of the quantity of heat necessary to raise the temperature of the substance to which it relates; and as it would appear to be impossible that it can ever be so small as to be nothing, it cannot possibly become negative, or less than nothing. When heat is evolved by the compression of saturated vaponrs, it does not follow that there is any change of specific heat; and although in the case of saturated vapour of water, there is a change of specific heat to the extent ascertained by Regnault, yet heat cooled is not due to that change, but arises from the quantity of mechanical effect converted into heat. It would appear that Dr. Thomson's illustration of the quantity of heat necessary to evaporate a quantity of water being infinitely variable, is not complete, if it excludes the power or mechanical effect involved in the operation:—if this mechanical effect be introduced as an element, the heat ceases to be variable, and becomes what it ought to be, a constant quantity, with no variation but that pointed out by Regnault.

to see that the joint keys are in their places. Notwithstanding this examination, the writer is aware of accidents, some of a serious nature, having occurred in consequence of the joint keys getting displaced; and it was to obviate this, and to render the security of railway travelling independent of the faithfulness of such an examination by ordinary workmen, that he was induced to adopt this plan of joint-chair.

Previous to introducing this chair, the writer is not aware of any permanent way having been constructed on the plan recommended. It has now been used upon upwards of 45 miles of railway, and it has been found to suit the purpose, making a very smooth road. So far as safety is concerned, this chair appears to be equally as good as any kind of fish-jointing, whilst its first application and future maintenance are entirely free from complication.

A specimen was produced at the meeting, showing the manner in which the rail and chairs were placed. The arrangement is shown in Figs. 3 to 6, Plate vii.; Fig. 3 being an end elevation of the common intermediate chair, with the rail in section wedged in its place; Fig. 4 an end elevation of the improved joint-chair, with a rail end in its place; whilst Figs. 5 and 6 are side elevation and plan of the ends of two rails, with the joint-chair and the adjoining intermediate chair on one side.

ON BLOWING FANS.

By Mr. John Downie.

(Illustrated by Woodcuts.)

About ten years ago the writer had his attention drawn to the subject of fan-blowing, in consequence of the great absorption of power by two 4 ft. fans, of the ordinary eccentric construction, applied to the blowing of foundry cupola furnaces at the works with which he was then connected; and with the view of endeavouring to economise that power, a series of experiments were then begun, which have since led him to adopt a totally different form of wind-case and rotating propeller. Figs. 1 and 2, Woodcut, are vertical sections of the apparatus, and a working specimen of a 3 ft. drum or propeller is exhibited, which last will give a much better idea to practical men of the general construction employed.

The first alteration from the old stereotyped form was suggested by the fact that, in nearly all fans of the ordinary construction, a considerable outward current, or "blowing-out" of the air, takes place at the ear opening—generally in the directions indicated by the arrows at A in

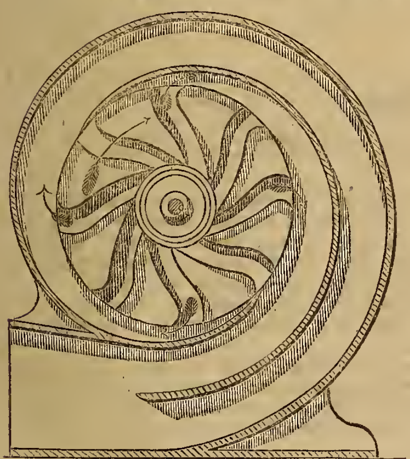


Fig. 1.

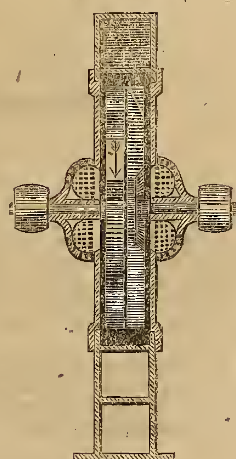


Fig. 2.

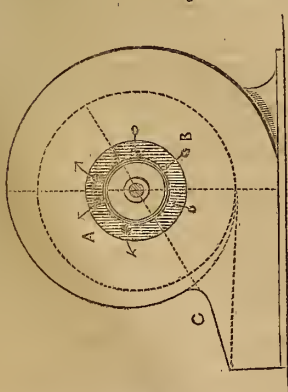


Fig. 3.

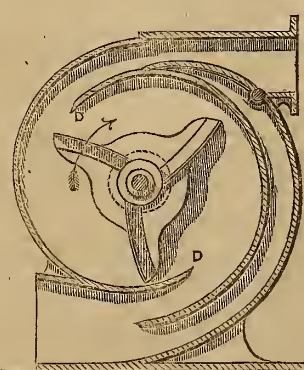


Fig. 4.

Fig. 3—while the air rushes in at the lower portion of the opening, as shown by the arrows at B.

Conceiving that if this counter-current (through which the propelling blades or paddles had to be driven) were removed, a considerable saving in power and gain in effect might reasonably be looked for, the first alterations that were made went solely to remedy that defect. This was done by bringing the circumferential sheet-iron of the case down to the vertical centre line—a piece, of the form indicated by the dotted lines, being introduced in the common fan, so as to do away with the blunt part, C, and presenting instead a knife-edge, as it were, at the point of delivery. This simple expedient had an extraordinary effect in reducing the "blowing-out" qualities of the fan under experiment, although the fan still adhered to a little of its old practice.

It, however, gave sufficient indication of being a move in the right direction, by saving power and gaining effect, to induce the writer to design a new fan, to blow in two opposite directions at the same time, and to do the work of the two fans already referred to. This gave an opportunity for going into the question of the general proportions of the parts of such a machine. The first thing that strikes one as peculiar in a 4 ft. fan of the usual proportions, is the large allowance of ear opening (generally half the diameter of the blade), compared with the area of the discharge aperture (usually about 12 in. square in such a fan); and the inquiry naturally arises, why an area of more than 900 sq. in. should be allowed in the ear openings, to supply a discharge of about 144 sq. in.? Again, the large ear openings necessarily induce a shallow case, and admit of only a very short blade or paddle, so that the inward current of air is met by the heels of the blades running at a very high velocity, and it does not, nor can it, impinge on these without considerable resistance. The blunt point, too, at C, Fig. 3, is not much in favour of speedy egress after the air has attained the velocity of the blades. In fact, it cannot be expected that air, brought gradually to a high velocity by circular motion, will, without a resistance, leave at a tangent the circle in which its motion has been generated; and it is this resistance which causes and explains the counter current, or "blowing-out" at the ear openings, and the consequent loss of effect and absorption of driving power.

The writer, following out these ideas, constructed the double eccentric 4 ft. fan blower, shown in section in Figs. 4 and 5. In this blower the ear openings are of only 1-3rd the diameter of the blades, and have an area of about 400 sq. in. The points of discharge or deflection, D, are carried round about 45° past the vertical centre line of the fan, and the discharge aperture is increased to 36 in. × 12 in., or to an area of about 430 sq. in., so as to be a little in excess of the inlet area, and thus secure free egress to the air, which, being driven off in the circle in which it is set in motion simultaneously at the opposite knife-edge points, D, is then gradually brought to the straight line of the conduit pipe. The rotating propeller was similar in form to those used in the two superseded fans, the only difference in construction being the substitution of a wrought-iron centre disc, to which the blades were riveted, instead of the usual cast-iron centre. It may here be observed, that the same driving pulleys and gearing were used in both cases. The distance the air had to travel before discharging into the cupola furnace was about 100 ft., and the indicated pressures were all taken at the tuyere pipe at that distance from the fan. The power absorbed was ascertained by a dynamometer brake, and the pressure of the air by a syphon tube filled with water in the usual way.

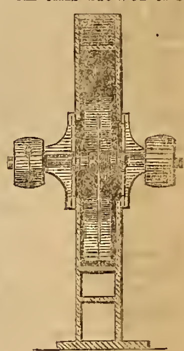


Fig. 5.

The following experimental data and results exhibit the effect obtained by altering the form of the fan chest or wind case:—

Kind of Fan.	Diameter.	Revolutions per Minute.	Velocity of blade tips in Ft. per second.	Pressure in In. of Water.	Power Expended.
No. 1, Common	4 ft.	1,500	312·5	7½	16 H.P.
No. 2, Common	4 ft.	1,200	250	5	12 H.P.
No. 3, Double eccentric (Figs. 6 & 7)	4 ft.	1,500	312·5	10	14 H.P.

Fans Nos. 1 and 2 thus absorbed altogether 28 H.P., these results being obtained whilst the fans were blowing into the tuyeres, the area of which was about 100 sq. in.

The results noted for fan No. 3 were obtained when discharging air both ways; whilst on the blast being concentrated to one set of furnaces (the velocity remaining the same), the pressure was equal to 12½ in. water, about 9¾ H.P. being expended. The tuyere area of the cupolas was enlarged fully 50 per cent., or to about 160 sq. in., when the new fan was started, the results consequently showing a greater proportionate advantage arising from the alterations.

Other fans were constructed on the same plan with similar results, but with no modification in their construction, save that the wind case formed a separate part, and side cheeks were bolted on of the full diameter of the blades; so that in case of accident, or for repair, they might be taken off, and the propeller removed from the case, without taking the whole machine to pieces. This arrangement has frequently been found of much importance in the writer's practice, as fans so constructed have been taken apart for trifling repair and put together again in little more than half an hour, thus saving great trouble with furnaces and much valuable time, a consideration of no mean importance to the ironfounder.

We now come to the modified form of propeller represented in Figs. 1 and 2. Hitherto the form of wind case was nearly all the writer had attempted to alter; but about five years ago, a new feature presented itself in the requirements of two large cupola furnaces, which were connected to a chimney 200 ft. high by a flue near their tops, and consequently necessitated a very great increase in quantity and also in density of blast. On looking around for something to supply this want, and on comparing notes, the writer found that the fan with improved wind case (which has just been described) gave as good results for the same expenditure of power as any of the ordinary fan blowers then in use, and he set about designing a propeller of the form exhibited and represented in Figs. 1 and 2. This fan or air-propeller is made with curved thoroughfares diverging from points near the centre to the periphery of the drum, the whole being closed at the sides, and also between the outer ends of the thoroughfares round the circumference.

The objects the writer had in view in adopting this construction were—

1st. To prevent the air in front of the blades from getting over their side edges and ends, to react inside the wind-case.

2nd. To prevent the air driven off at the points of discharge from getting back again, and to thus compel it to go right ahead.

3rd. To cause the air driven off in the circle in which it is set in motion (as already described) to leave the case with the minimum resistance, and thus produce a better effect.

The results obtained on trial exceeded the writer's expectations, and they forcibly indicate that the propulsion of a forced current of air is a matter as yet little understood by mechanical men, and that a large field for investigation is still open to all who choose to give the subject their attention. To ironfounders particularly the per-centage of saving obtainable in time and fuel is enormous, and will in a few months' time well repay the expense of a properly-constructed machine.

The following tabular statement gives the results obtained by the fan, combining the various improvements:—

Kind of Fan.	Revolutions per Minute.	Velocity of Blade Tips in Feet per Second.	Pressure in Inches of Water.	Power Expended.	Area of Tuyere Discharge.
30 inch Fan	1,100	162·5	$8\frac{1}{2}$	abt. 5 H.P.	150 sq. in.
36 inch Fan	1,200	188	$11\frac{1}{2}$	,, 8 H.P.	500 ,,
Do.	1,500	235	$15\frac{1}{2}$	,, 10 H.P.	500 ,,
50 inch Fan	1,000	218	15	,, 12 H.P.	500 ,,
Do.	1,200	260	$18\frac{1}{2}$	,, 15 H.P.	500 ,,

These are the results obtained with the fans in use at the North Woodside Iron Works, where they may be seen at work during melting time by any one desirous of examining them.

The writer some months ago supplied a 50-inch fan to the Anderston Foundry Company for their large 10 ft. cupola furnaces, but as their steam-engine was already burdened, they could not spare the power necessary to drive it efficiently. It was taken out after trial, and their old one, a very excellent specimen of the common construction, 42-inch diameter, again put in. During the time the new one was in use, the results were noted by Mr. M'Ilwham, the manager, who has very kindly furnished the following details:—

"The old 42-inch fan running at 1,314 revolutions per minute, the velocity of the blade-tips being 240 ft. per second, gave 10 in. of water when blowing into tuyeres with an area of about 450 square in.

"The new 50-inch fan, running at 1,054 revolutions per minute, the velocity of the blade-tips being 230 ft. per second, gave 14 in. of water, when blowing into the same tuyeres."

The conclusions to be drawn from the experiments described are, that with a given proportion of driving power, a considerable increase in effect, both as regards pressure and quantity of air discharged, may be obtained, by a suitable adaptation of parts in the fan blower; and no doubt many improvements remain to be made in this much-neglected, though most valuable assistant in the daily enlarging operations of the engineer and ironfounder.

ON A BLOWING FAN.

By W. J. Macquorn Rankine, LL.D.

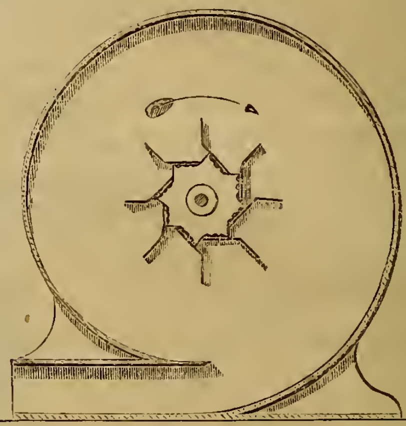
(Illustrated by Woodcuts.)

To reduce to the smallest possible amount the waste of power in a blowing-fan, the changes in the velocity and direction of motion of the air ought to be made as gradually as possible.

The velocity of the air required in the discharge pipe is in general considerably less than that of the air in contact with the tips of the fan-blades. In order that this diminution of speed may take place by degrees, and may give rise to increased pressure, instead of merely wasting power in eddies, friction, and noise, there should be a certain clear space all round the fan, in which the air, after leaving the fan-blades, may perform a certain number of revolutions before being discharged. The advantage of such a space appears to have been known by practical experience to Mr. Appold some years ago. Mr. James Thomson was the first to point out the theoretical reason for it.

In the experimental fan made by Mr. J. R. Napier and the author of this paper, the mean radius of the case is to the radius of the fan, as the velocity of the tips of the blades is to the velocity of the air in the discharge pipe; that being the proportion indicated by theory as the best.

Besides the change of velocity which the air undergoes in passing from the fan to the discharge pipe, there is the previous change, both in velocity and direction of motion, when the air receives its whirling motion from the fan; and this also ought to be performed as gradually as possible. In the experimental fan referred to, the blades are made of the



curved form shown in Fig. 6, Woodcut, so that their inner edges *cleave* the air without striking it. The air, in passing outwards along the blades, gradually receives from them a more and more rapid whirling motion, until at the outer edges, where the blades are in the direction of radii, the velocity of the air is the same with that of the blades.

The fan works with no noise, except a slight fluttering sound, inaudible beyond a few yards. The absence of noise is a sign of economy of power.

The proportion of the power wasted during the changes in the motion of the air, may be estimated by comparing the pressure which would be produced in the discharge pipe, if there were no waste of power, as computed theoretically, with the actual pressure as ascertained by experiment.

The theoretical pressure depends on the figure of the blades, and the ratio of the diameter of the fan to that of the case, and is determined by a mathematical equation, which will be found in an appendix to this paper. It is sufficient to state here, that the theoretical pressure at the outlet of a fan formed and proportioned like that now described, is that due to the weight of a column of air of *one and three quarter times* the height from which a body must fall to acquire the velocity of the tips of the blades.

In the experiment made, the number of turns per minute was 1,000.

The circumference of the fan is 11 ft.

Hence the velocity of the tips of the blades was 183 ft. per second.

The height due to that velocity is 520 ft.; and one and three quarter times that height is 910 ft.

It is usual to measure and state the pressures produced by blowing machines in inches of water. For the purposes of this calculation, it is sufficiently accurate to take air as having one eight-hundredth part of the specific gravity of water.

Then 910 ft. of air $= \frac{910}{800} =$ 1·14 ft. of water $=$ 13·7 in. of water, which is the theoretical pressure at the *commencement of the discharge pipe*.

The pressure was ascertained by experiment at a part of the discharge pipe between 40 and 50 ft. from the fan; the pipe was about 1 ft. square,

and the loss of pressure in overcoming the friction in it must have been at least 2 in. of water.

Hence we have—

	In. of water.
Theoretical pressure at outlet of case, as above	13·7
Less friction in discharge pipe	2·0
Theoretical pressure at the part of the pipe experimented on	11·7
Actual pressure	11·0
Leaving pressure wasted in the moving of the air by the fan..	·7 in.

or *one-nineteenth* part only of the theoretical pressure at the outlet of the fan-case.

More experimental fans are now being made, and the results produced by them will be communicated to the Institution.

Dimensions of Fan.

Diameter of each ear	20 in.
Do. of fan..	40 „
Least radius of case	36 „
Greatest	48 „
Breadth	12 „
Discharge trunk	12 in. sq.

Appendix.

The following is the formula to calculate the theoretical pressure at the outlet of the fan-case:—

Let V = velocity of tips of blades, in feet per second; v = velocity of air discharged at the outlet of the case, in feet per second; then theoretical pressure in feet of air $= \frac{2V^2 - v^2}{64 \cdot 4}$; finally, the theoretical pressure in feet of air $\times \frac{12}{800}$ = theoretical pressure in inches of water, nearly.

The difference between this and the actual pressure shows the loss by friction and agitation of the air.

ON POINTING FIRE-ARMS.

By Mr. J. G. Lawrie.
(Illustrated by Woodcuts.)
[ABSTRACT.]

Every improvement in the power of a fire-arm, every increase in the distance to which shot can be thrown, demands additional accuracy in pointing the piece.

When the soldier's musket was harmless at a distance beyond 250 yards, and field-pieces were limited in effective power to 700 yards, very different means sufficed for taking aim than are desirable with a power of impulsion increased fivefold. Fire-arms are now constructed, as regards the distance to which and the accuracy with which they throw projectiles, with a perfection unknown a few years ago. The soldier's former musket, called "Brown Bess," was incapable of throwing a shot with a force to penetrate beyond a distance of 200 to 300 yards, and even at that or a much less distance was altogether uncertain of hitting. The same imperfection existed in all classes of ordnance.

To remove this uncertainty of hitting in the use of small arms, or, in other words, to make a musket, when placed in a fixed position, throw a shot twice through the same path, rifled barrels are successfully employed, and there are grounds to believe that by means of Whitworth's polygonal rifle bore, the same important desideratum will shortly be accomplished with ordnance. Before the invention of the Minié bullet, rifled barrels were objected to in consequence of the difficulty and time required in loading the gun; but now that this bullet so facilitates the loading of a rifle as to require for that operation no more time than is necessary to load a plain barrel with a plain ball, the soldier's musket has in the Minié rifle reached a high degree of perfection.

What is the history of this unrivalled weapon? Its history is the same as that of all other revolutionary improvements. The work of twenty years, the labour of a lifetime, was necessary to introduce it. In 1826, M. Delvigne first invented it, and having made experiments with the elongated ball, brought it before the French authorities. From 1826 to 1837 no official would listen to him, and he had to contend against the ignorance and prejudice of all the civil and military authorities of France, although he pointed out that the best troops of France under the most experienced officers had been beaten by the rifles of the peasantry of the Tyrol. The loss, however, of officers and men in Algeria was so great that in 1838 the Duke of Orleans, before going to Africa, organized a battalion of the *Tiralleurs de Vincennes* (then called *Chasseurs d'Afrique*) to take with him. In 1844, Captain Minié invented the hollow ball. At length, in December, 1854, during the heat of the Crimean war, through the influence of public opinion, brought to bear chiefly by the "Times," Mr. Sidney Herbert, the Secretary-at-War of the British Government, in the House of Commons announced the intention of the Government to arm the whole of the troops with the Minié rifle, and that these weapons were being issued as fast as they could be supplied from the manufacturers.

Thus, a period not much short of thirty years elapsed before the superiority of the rifle barrel, with its peculiar ammunition, was established.

Perfection in ordnance, similar to that attained with small arms, is now the great engineering problem of the day in gunnery. The malleable iron gun made by the Mersey Steel and Iron Company, which possesses great power of throwing heavy shot to distant points, has hitherto sustained all the proofs to which it has been subjected, and is now at Shoeburyness, ready for service. The 36-in. malleable iron mortar made by Mallet, in London, and called Lord Palmerston's Mortar, has not yet proved itself quite sound, having, on each of the two trials made with it, shown symptoms of defective strength; but it is believed that this mortar will yet be made effective. The object of these arms, and of others which have been made, is to throw heavy metal to great distances; and that object is probably in a fair way of being accomplished; but no attempts to construct rifle ordnance so as to throw heavy weights with accuracy to great distances have hitherto been equally successful. Lancaster's oval bore has proved a total failure, and other efforts having been equally fruitless, attention is now closely directed to Mr. Whitworth's rifle cannon with a polygonal bore. From this gun very favourable results are anticipated.

In proportion, however, as the power of fire-arms is increased, the problem of how to use them presses for solution. When firing at distant objects, or indeed at objects beyond a very limited distance, the piece is elevated to an angle depending in amount upon the remoteness of the object, and therefore a means of arriving at a knowledge of the distance of the object to be fired at is essential to an effective use of the weapon.

At the Government School of Musketry at Hythe, in the south of England—a school established for the purpose of instructing the troops in the use of the Minié, now called the Enfield rifle—the soldier is instructed how to handle or manipulate his rifle, and how to judge of the distance of the object to be fired at. The first of these instructions is manifestly of small importance, and of easy acquirement, compared with the second. A soldier of ordinary intelligence should speedily become familiar with the mode of handling a rifle; but it would appear to be exceedingly difficult to convey, even to a soldier of unusual intelligence, the power of judging with much accuracy whether an enemy be at the distance of 600, 800, or 1,000 yards, and upon the possession of that power of judging the distance, depends the effective use of the weapon.

The solution of this problem in the manner pointed out at Hythe, is rendered materially more difficult by the varying circumstances in which a soldier is placed by excitement, by change of ground, change of atmosphere, and fatigue.

When an object is distant 100 ft. or 100 yards in front of the place from which an estimate is made of the distance of that object, the difficulty of making that estimate with any accuracy has probably been often experienced by engineers; but if there be such difficulty with so short a distance as 100 yards, how much greater must it be when the object is distant 3-4ths of a mile! According to Sir Charles Shaw, the accuracy of firing by ordinary troops when the distances are known is remarkable, but those very troops when required to fire consecutive shots upon an enemy approaching at a trot or gallop, would probably be far less successful when in possession of no other means of knowing their distance, than their own estimate by the eye.

The Hythe instructions for judging distance appear exceedingly crude, and seem but little suited for an effective use of the new and powerful fire-arms. Instead of the uncertainty which appears to surround the plan of the instructions, another method of procedure, consisting chiefly in a change in the sight, seems to supply not only the information aimed at by the instructions, but also to remove an imperfection in the construction of the rifle as at present made.

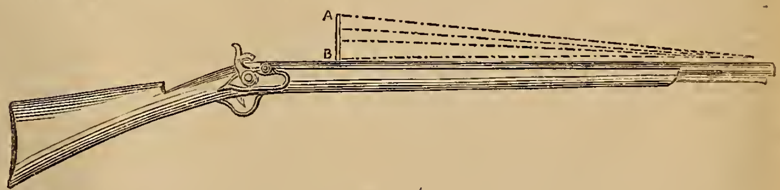


Fig. 1.

The rifle at present in the hands of our troops is represented in Fig. 1, Woodcut. A sight is placed on the top of the barrel, at A B, and is so constructed that the soldier can alter the height of the top of it, by pushing up or down a slide working upon two guides.

In using a rifle, the soldier first, in conformity with the Hythe instructions, estimates the distance of the object, then adjusts the top of

the sight, A, to the point graduated as corresponding with that distance, and putting the rifle to his shoulder, elevates the point until his eye—the top of the sight — and the muzzle are in line. If the stock of the musket used in this manner fits the arm of the soldier when firing to one distance, it manifestly cannot fit it when firing to any other—an objection which every marksman knows is by no means immaterial.

Two forms of sight have been devised by the writer—one for ordnance and one for small arms; or rather one for distances under 1,000 yards, and one for greater distances. The sights are very simple, and depend upon the principle that the more distant an object is, the smaller it appears.

For long distances, the sight consists of a small telescope, which is provided with two fine steel wires, or, as is customary with opticians, two threads of spider's web. These threads are placed across the object-glass at its focal distance, and can be separated or approximated in a manner which by a micrometer screw affords the means of measuring the distances between them to any amount of minuteness. Thus, whether the object be cavalry or infantry, the distance is known by a scale graduated on the telescope, indicating the distance asunder of the threads.

The form of sight for field-places and rifles, which are not used for distances so great as ordnance, and therefore do not require so much power, is intended to be always attached to the weapon itself. In Fig. 2,

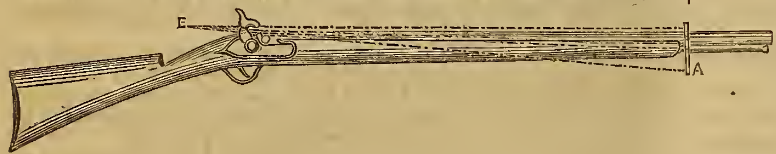


Fig. 2.

a rifle is shown with one of the several forms of this sight.

A sight, A, shown enlarged in Fig. 3, is placed on the barrel. This sight is a plate having apertures cut through it, which apertures, 2, 3, 4, &c., correspond respectively to the apparent height of a man at the distance of 200, 300, 400, &c. yards; and therefore an eye at E, looking through the aperture 2, at a soldier 200 yards off, will just see him from head to foot. In the same way, looking through the aperture 3, it will just see a soldier 300 yards off, and so on with the other apertures. But in firing at an enemy 200, 300, or 400 yards off, the barrel must, in each case, be elevated to certain angles, each distance having an angle of its own, depending upon the power of the rifle.

In constructing the sight, the several apertures are cut in such positions as to require the elevation of the barrel of the rifle to the proper angle, in order to make the object visible through the corresponding aperture. If, in looking through the aperture 3, for example, the object be seen from head to foot, the barrel is at that moment elevated to the proper angle; and in the same way, if in looking through any other aperture the object be seen from head to foot, the barrel is simultaneously elevated to the proper angle. Thus, in using the rifle, the soldier has no concern with the distance of the object, but has to perform only the one operation of looking at the object through the aperture which contains it from head to foot—a mechanical process unaffected by any external circumstances of ground, atmosphere, or change of dress.

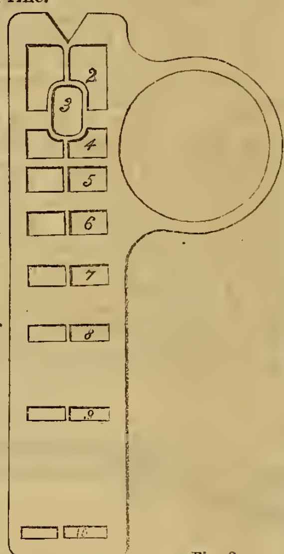


Fig. 3.

If the objects, of which the distance is measured, whether by this last sight, or by the telescope, be of an invariable height, and if sufficient care be taken in the observations, results of very considerable exactness are obtained—results, however, not comparable to trigonometrical measurements, but vastly superior to any estimate the most practised eye could make.

These sights appeared to the author so simple in principle, and so simple in construction, that he made a search to learn whether they had not been previously in use. The result of the search was to ascertain from "Coddington's Optics"* that the same principle, embodied in a different mechanism, had been used for astronomical purposes, and also that an instrument called the *stadia*, which consists of two divergent limbs, like two sides of a triangle, has been or is in some use in the French service. This instrument is held before the eye at a distance determined by the length of a cord grasped in the teeth, and is graduated to show the distance of the object, which corresponds to the distance from the apex of the parts of the divergent limbs, which just span the object.

It is, therefore, not new to measure distances by telescopes, nor by instruments like the stadia; but the author believes it is quite new to elevate or point fire-arms by mechanism in which a telescope or other sight is used in such a way that the single act of guaging the object elevates the barrel to the proper angle. For long distances the author uses the telescope sight in this manner, and for shorter distances the sight described in Fig. 3, or another form depending on the same principles.

In reply to an observation respecting the difficulty of adjusting the elevation of a rifle, when firing at troops in a kneeling or lying position, Mr. Lawrie said his sight could do no more than common sights under such circumstances. In reply to a remark that the sight was in an awkward position at the muzzle of the piece, and would be liable to injury, he said it could easily be made strong enough, and it might be made of considerably thicker metal than the barrel, without inconvenience.

* Edition 1825, page 129.

BRITISH ASSOCIATION.—LEEDS MEETING, 1858.

THE PATENT LAWS.

Section G.

Report of the Committee of the British Association, presented to the Mechanical Section by W. Fairbairn, F.R.S., President:—

The subject of the patent laws has frequently occupied the attention of meetings of the British Association, and committees have been, from time to time, appointed for the purpose of considering how those laws might be rendered more efficient for the objects with which they are maintained. Your Vice-President, the Rev. Vernon Harcourt, in the inaugural address at the first meeting of the Association, held at York, September, 1831, in which he expounded the objects and plan of the Association, referred to those laws as an instance in which fiscal regulations interfered with the progress of practical science, and as failing to give protection to property in scientific invention, to the same extent as protection is given to every other species of property, and he suggested a revision of those laws as one of the subjects to which a scientific association might be justly expected to call public attention, and your Vice-President, Sir David Brewster, and others, have, on several occasions, brought the subject before meetings of the Association.

By the Patent Law Amendment Act, passed in the session of 1852, the rights of the inventor to property in the offspring of his brain, and in the creations of his intellect, when embodied in products of national industry, were fully recognised; provisional protection to that property was secured to such inventor, from the date of his application for a patent; one proceeding was substituted, and one patent issued, extending to the whole of the United Kingdom, instead of three proceedings and three patents, separate and distinct, for each of the three countries, England, Scotland, and Ireland; property was created, and protection obtained for six months by a payment of £5 for three years by a payment of £25, and for the further terms of four and seven years by additional payments of £50 and £100 respectively, instead of by the payment of upwards of £300 in the first instance, under circumstances of such uncertainty as threw discredit on the whole system; the specifications of all patents are to be printed and published, and sold at extremely low prices, a benefit to the public as well as the inventor which it would be difficult to estimate too highly; and, lastly, provision was made for the regulation of matters relating to patents, by Commissioners furnished with ample powers for the purpose.

This Act came into operation on the 1st of October, 1852, and the experience of the first two years showed that the payments by inventors, upon the above scale of charges, would be at the rate of more than £50,000 per annum, without including the further or additional payments for the maintenance of the patents for the further terms of four or seven years, after the expiration of the first three or seven years respectively. At the meeting of the British Association in Liverpool, September, 1854, a committee, presided over by the Earl of Harrowby, was appointed "for the purpose of taking such steps as may be necessary to render the patent system, and the funds derived from inventors, more efficient and available for the reward of meritorious inventors, and the advancement of practical science." This committee communicated with Earl Granville and Lord Brougham, to whose exertions and watchful care the passage of the measure of 1852 was attributable, and made a report to the meeting of the British Association held in Glasgow in the following year, when the subject of the tax on inventors, and the appropriation of the funds so levied, was fully discussed; and another committee, consisting of his Grace the Duke of Argyll, the Earl of Harrowby, Colonel Sabine, the Master of the Mint (Professor Graham), Mr. Fairbairn, and Mr. Webster, were appointed with similar powers. The Glasgow Committee addressed a memorial to the Lord Chancellor (Lord Cranworth), calling attention to the proceedings which had taken place at the various meetings of the British Association; to the numerous questions of administration and legislation then adverted to, or which might be expected to arise; and suggesting that her Majesty should be advised, in accordance with the provisions of the Patent Law Amendment Act, 1852, to appoint others than the official Commissioners, and to make the working of that Act the subject of immediate inquiry.

At the meeting of the British Association held at Cheltenham in 1856, a committee, consisting of the Earl of Harrowby, Lord Stanley, M.P., Mr. Fairbairn, Professor Graham (the Master of the Mint), Mr. James Heywood, Mr. Commissioner Hill, General Sabine, and Mr. Webster, were appointed with like powers. The Earl of Harrowby and Mr. James Heywood communicated personally with the Lord Chancellor; Lord Stanley took a

warm interest in the subject, embodying his views on the necessary alterations in a published pamphlet, but up to this time the objects in view have not been attained, and it will be for this meeting of the British Association to consider what further steps should be taken.

The printing and publication of the specifications has led to results which were hardly anticipated, as to which the following extract, from a report of the Commissioners of Patents in 1856, will be read with interest:—

"The Commissioners of Patents have presented complete copies of all their publications to such of the Government offices and seats of learning as have applied for them, and to the principal towns in the United Kingdom, on condition of their being daily open to the inspection of the public free of charge. In their selection of towns for this gift, they have beeu guided by the number of applications for patents proceeding from each.

"This gift has in most cases laid the foundation of public free libraries where none previously existed. In some instances, where tbe local authorities hesitated to accept the works on account of the incidental expenses, the custody has been solicited and temporarily undertaken by scientific institutions, which have modified their by-laws to enable a free admission to the public daily to the library in which the works are deposited."

The same report, after enumerating a list of the places which have received the works, says:—"It is satisfactory to find that these national records of invention are especially consulted by that class whose skill in the improvement of manufactures is so essential to the maintenance of the commercial prosperity of this kingdom," and adds the testimony of the librarians of several of the free libraries to the same effect.

Complete sets of the Commissioners' works have been sent to the Colonics, to many foreign States, to the Patent Office, Washington, to the Aster Library, New York, to the Franklin Institution of Pennsylvania, to the Public Free Library, Boston, U.S.; and the Hon. Charles Mason, Commissioner of Patents for the United States, addressing the Commissioners of Patents in this country, writes as follows:—

"The admirable example you have set in publishing the specifications and drawings in full, and putting them on sale at a moderate price, so that all can easily provide themselves with what they need for private use, will ere long, I trust, stimulate our own Government to do the like. Nothing short of this in the way of publication can give permanent satisfaction."

A free library and reading-room has been opened at the Office of the Commissioners of Patents, containing a large collection of works of reference, which, as the same report states, is numerously attended by professional men, the agents of foreign and provincial inventors, and by practical mechanics and operatives; and Mr. Woodcroft has collected a large number of portraits of inventors, and of models illustrative of the history and progress of invention, which it may be hoped at a no distant period will form a principal object in a National Gallery of Inventions and Museum of Inventions.

These and other undertakings, well suited to promote the advance of practical science and the interest of inventors, afford legitimate objects for the expenditure of the surplus funds levied on inventors, but when ample provision shall have been made for these objects, there will still be a considerable annual surplus.

The amount paid by patentees during the last year was upwards of £83,000, and after the commencement of the payment of £100 at the expiration of the seventh year, the amount levied on inventors will not be less than £100,000 per annum, a sum which as levied on inventors and inventions, may reasonably be expected to be expended on objects in which inventors have some interest.

In reference to this branch of the subject, the following questions would appear to arise for consideration:—

1. Should the present scale of payment be maintained or reduced, so as to leave no great surplus beyond what may be necessary for the official expenses?
2. If the present scale be maintained, how should the surplus be appropriated?

It appears that the second payment of £50 before the end of the third year is not made in respect of more than about one-fourth of the whole number of patents issued, that payment being made on about 500 out of 2,000 patents, so that 1,500 are permitted to lapse, the cost of which in money to the patentees cannot be taken at less than £75,000, in addition to the expenditure of time and labour on the respective inventions. Can anything be done to diminish this loss, beyond affording every facility for access to information as to what has been done before, and the improved education of the people?

In addition to these considerations and suggestions in connection with the new system as recently established, and which are of the fiscal character referred to by your Vice-President, there are some other questions deeply affecting the interests of inventors and the advancement of practical science, which it would not be proper to close this report without adverting to.

The Patent Law Reform of 1852 was never regarded as a final measure. It was but a first instalment, obtained under great difficulty; it only laid the foundation of the superstructure yet to be raised. The following important questions of—1. Improved protection to the property so created; 2. The amendment of existing patents and specifications, so as to save what is really new and useful, according to the amendment of the Patent Law, as effected by Lord Brougham in 1835; 3. The confirmation of an invention re-invented and introduced into successful use according to the principle of the confirmation of rights effected by the same noble lord; 4. The extension of the term of patents which have not yielded adequate remuneration to the inventor; 5. Reward to a meritorious inventor, who, from causes wholly beyond his control, has been a great loser by, or derived no benefit from, a meritorious invention, from which the public have derived great benefit; 6. A system of compulsory licenses under existing patents;—are questions all of which were omitted advisedly by the promoters of the recent measure, their attention being directed mainly to the destruction of the existing, and the establishment of a new system of creating property in inventions.

These, with other amendments and matters of minor importance, which the experience of six years of the working of the new system has disclosed, will involve further legislation, and the consolidation and repeal of no less than sixteen statutes or parts of statutes, an object of great importance to every inventor.

Your committee now remit this subject to the consideration of the meeting of the British Association, deriving confidence from the belief that the times are not unfavourable for further action, and that the town and neighbourhood in which the Association is now assembled may appropriately claim to take a prominent part in the consummation of those reforms which have occupied the attention of so many meetings of the British Association.

Leeds, September 22, 1858.

ON A NEW FLOATING DRY DOCK.

Section G.

By Geo. Bayley.

The dock described in the following paper was designed by Mr. Bayley in 1836, for a South American Government, and intended to be moored in deep water, and ride with a ship of war with safety during ordinary gales. The paper was illustrated by models of a dock of about 400 ft. in length, 80 ft. wide, and 20 ft. deep; as also by another representing a screw steamer of about 300 ft. in length. From the illustration it will be seen that ample space is secured all round the vessel for the performance of any work that may be required to the outside of the ship.

The rapid increase of irou steamers and ships in foreign voyages, and the necessity for frequent cleaning of the bottoms from marine vegetation, etc., seems to require additional facilities for performing these necessary operations, and renewing the coating of paint, or other protective covering, abroad, with dispatch and economy.

The existing dry docks abroad are, many of them, situated where, there being no rise and fall of tide, the water has to be emptied out of the dock, either by manual labour or machinery, and from the extremely faulty construction and execution of the work, it not unfrequently occurs that constant baling or pumping is required during the whole time the ship is in dock; of course, this involves great additional expense; and, besides, such docks are commonly so extremely damp that paint does not always dry in them.

The port, or rather open roadstead in which it was proposed to place the floating dock, whose model is submitted to the Association, had a rise of tide of about 6 ft. The shore consisted of a fine sand, frequently shifting with changes of wind, &c., to the extent of many feet in depth, so that the difficulties presenting themselves to the successful construction and subsequent use of a dry dock, seemed to be insurmountable, excepting at a cost beyond the means which the Government had at its disposal.

A patent ship-way had been suggested, and the Government were disposed to adopt it, but then the danger of being sometimes sanded up so as to be useless, and at other times severed away so as to be unsafe, were serious objections to its adoption—to say nothing of the objections to the use of a ship-way for long and heavy ships.

These considerations led to the suggestion of a floating dock, and to meet the peculiarities of the place, it was proposed to construct the dock so that it could be immersed or sunk down to any depth that might be required to admit the ships of various classes, and be strong enough to rise with them without straining the ship.

Three things had to be combined: strength, rigidity, and buoyancy. The needful strength and rigidity were to be secured by a very simple system of bracing and trussing, and the whole framing covered with planking, well secured and made water-tight; this space was subdivided longitudinally and transversely so as to obviate any risk from the rushing of the water from side to side, or from end to end of the dock, and at the same time these longitudinal and transverse partitions would add to the strength and rigidity of the entire fabric.

A transverse section of the dock would show that the floor of the dock is a framed beam, consisting of two tie-pieces about 4 ft. apart, with queen posts in the centre under the ground or lower tier of keel blocks, with tie-bolts introduced where necessary. The sectional area must be proportioned to the *entire* weight of the dock with the ship, so that if desired it may float with its upper internal surface above the level of the external water. The angular or rectangular space between the outer and inner planking of the sides must be of sufficient volume to allow the dock to be sunk to any required depth to receive the ship.

The dock itself must be either ballasted with sufficient weight to render it specifically heavier than water, in order that it may be readily sunk to the required depth.

It was proposed to have an engine fixed to pump out the water from the sub-divisions of what I may, perhaps, be allowed to term the flotation space, between the immersed outer casing or planking, and also to drive saws and any other tools that may be required for carrying on the repairs.

At the time when the dock was designed, wood was the material proposed to be used—but now it would be desirable to construct such docks of iron, which is so peculiarly suited to meet all the requirements of such structures as to strength, rigidity, and buoyancy, at less cost than timber under almost any combination of circumstances.

The sectional or pontoon docks of America are nearly identical as to their buoyancy, but they can only be used in still water.

The ordinary floating dock has been long in use both in Great Britain and abroad, but from its imperfect construction it was so flexible that ships were frequently severely strained and injured by the twisting and bending of the dock.

A very ingenious modification of the sectional dock is used at Lyons for cleaning and repairing the iron steamboats plying upon the Rhone. They are simply square punts, with a portion cut out on two of their sides and fitted to the form of the bottom of the vessel. They are hauled under the vessel and then pumped out, when they lift the vessel completely out of the water, so that all parts of the bottom can be got at and repairs of any kind effected. Such pontoons might be more generally used with advantage for lifting iron ships out of the water in lakes and still water.

It is unnecessary to enter into details that will at once present themselves to any one constructing a floating dock on the plan suggested. Local circumstances and requirements will determine many of the questions that may arise. The peculiar advantage of the kind of dock now suggested is its adaptation to places where, from local circumstances, it is difficult, if not impossible, to build secure and substantial dry docks on the shore, excepting at such a cost as would preclude their erection, for example, in the harbour of Malta, and others in the Mediterranean, where, at present, the vessels are hove down to perform the repairs to the bottom. This is a simple operation, and comparatively unattended with danger to small vessels, but large ships are all more or less strained by the operation.

Fig. 10, plate 135, is a cross section. The cubic contents of the part *a a* must be equal to a volume of water of the same weight as the *ship*, and the sides of the dock above the floor of the dock C; and the cubic contents of the sides *b b* of the dock should be, at least, equal to the weight of the ship. The dock being, in fact, a hollow beam, pressing upwards on its centred line—the keel—care must be taken to arrange the trussing and bracing to provide for this and for torsion.

ON THE GRESHAM BUOY FOR RECORDING THE LOSS OF MISSING SHIPS AT SEA.

Section G.

By James Oldham, C.E.

In an enterprising, commercial, and maritime country like Great Britain, with its tens of thousands of ships of every class and description navigating in all directions and in every latitude the great highway of nations—encountering the storms, and risking the rocks and shoals of every navigable part of the globe, it is not surprising that losses and disasters should occur. Few, however, will be prepared to hear that during the last fifteen years, ending with 1857, there were wrecked, burnt, or missing, 8,998 sailing vessels, and 175 steam vessels, giving a total of 9,173, and also a total of 1,805,367 tons, equal to 120,357 tons per annum, and showing an average of upwards of 196 tons for each ship, and an average also of 611 ships per annum. It may not be out of place here to refer to the ships of the British royal navy, and also of the total number in the mercantile navy.

The British royal navy in 1857 consisted of 862 ships of all classes and kinds, and there are amongst them 470 mounting 15,885 guns, varying, according to the ships, from 1 to 131 guns; and there are 156 gunboats (say 2 guns each) with 312, making a total of armed ships of 626, and a total of 16,197 guns. The remaining 236 vessels consist of troop-ships, despatch-boats, lighters, receiving-ships, store-ships, &c. Such a navy requires no comment from me, but is able to speak for itself. If the royal navy, however, exhibits so noble a front, I think the mercantile navy is equally to be admired, for during 1857 there were British registered vessels 37,014, having a tonnage of 5,519,154, giving an average of upwards of 149 tons to each vessel.

I find in the table No. 2 that in 1843 there were 30,983 registered vessels, and during that year the loss was 697, giving a loss of 2·25 per cent.; and in 1857 there were 37,014 vessels as already stated, and a loss of 662, reducing the per centage to 1·78, showing an improvement of ·47 per cent. But as these are isolated periods, I will state the result of six years, viz., 1843, 1844, 1845, and 1855, 1856, 1857; the three former I give respectively:—

1843	2·25
1844	1·65
1845	1·69
Mean	1·86

—and the three latter—

1855	1·36
1856	2·00
1857	1·78
Mean	1·71

—exhibiting an improvement only of ·15 per cent.

In 1828 the number of registered ships amounted to 24,095 and the losses 555, giving 2·30 per cent. loss.

The statements are grounded on returns obtained from the General Register and Record Office of Seamen, the detail of which will be seen by reference to the following tables:—

Table No. I.

Number and Tonnage of Vessels Wrecked, Burnt, or Missing at Sea, in each of the Years from 1843 *to* 1857 *inclusive, distinguishing Sailing from Steam Vessels.*

Years.	Sailing Vessels.		Steam Vessels.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1843 ……	685	120,193	12	3,508	697	123,701
1844 ……	513	80,926	4	1,325	517	82,251
1845 ……	534	88,783	5	940	539	89,723
1846 ……	529	91,221	8	678	537	91,899
1847 ……	533	95,590	4	1,037	537	96,627
1848 ……	501	93,848	13	3,072	514	96,920
1849 ……	560	101,054	6	1,462	566	102,516
1850 ……	688	125,726	4	1,462	692	127,188
1851 ……	600	110,670	11	1,306	611	111,976
1852 ……	733	140,965	9	2,819	742	143,784
1853 ……	569	117,300	12	3,414	581	120,714
1854 ……	721	160,038	17	8,805	738	168,843
1855 ……	474	93,161	12	2,656	486	95,817
1856 ……	719	186,785	35	8,940	754	195,725
1857 ……	639	150,187	23	7,496	662	157,683
Total….	8,998	1,756,144	175	48,920	9,173	1,805,367

J. H. Brown, R.M., Registrar-General.
General Register and Record Office of Seamen, London, Aug. 13th, 1858.

Table No. II.—*British Mercantile Navy.*

Total Vessels Registered.

Year ending 31st December.	Vessels.	Tons.
1843	30,983	3,588,387
1844	31,320	3,637,231
1845	31,817	3,714,061
1846	32,499	3,817,112
1847	32,988	3,952,524
1848	33,672	4,052,160
1849	34,090	4,144,115
1850	34,288	4,232,962
1851	34,244	4,332,085
1852	34,402	4,424,392
1853	35,309	4,764,422
1854	35,960	5,043,270
1855	35,692	5,250,553
1856	36,012	5,312,436
1857	37,014	5,519,154

J. H. Brown, R.M.

How many of the ships enumerated in the first Table were of the class "missing at sea," and never after heard of, as in the case of the *President*, and how many human beings perished in the deep, we are not informed, but there can be no doubt that a fearful amount of lives were lost, and multitudes of families plunged into grief and mourning. I cannot help remarking here that there appears to me to be some *radical defect* existing, either in the education and examination of masters and officers of our merchant ships, and their general acquaintance with the laws of storms, the currents and charts of the ocean, or in the build, construction, and equipment of vessels; or it may be in each and all these that science is still deficient, but ought not to remain so. And is there not a want of more and better lighthouses on the coasts and continents of every sea? and also more and better harbours of refuge required, particularly on the coasts of these islands, and especially so on the coast of Yorkshire?

The immediate object of this Paper is to point out a mode by which a record of the loss of a ship at sea may be attempted, where otherwise no account would ever be obtained. It has long been a matter of deep concern and anxious thought to many to devise some plan, by which the total loss of ships and all they contained might have a chance of being made known to the world. Numbers of noble ships, containing valuable cargoes, and multitudes of precious lives, have sunk into the depths of the ocean, and not a fragment discovered, as a memorial of such sad events, thereby leaving us in the dark as to the locality, or the immediate cause of the catastrophe.

Some of these melancholy disappearances may have been caused through sheer stress of weather, whereby the ship has become so rent and torn, dismasted and disabled, as to render her at last an easy prey to the engulphing waves—others, owing to malconstruction, may have been torn asunder when encountering a heavy rolling sea, and others possibly by coming in contact with some of those enormous icebergs so common to the North Atlantic.

That losses do take place, attributable to one cause or another, of the particulars of which no account has ever been received, I would refer to the melancholy case of the steam ship *President*, in which so many valuable lives were lost, and to the present moment not a vestige of that noble ship or anything pertaining to her has been discovered.

She left New York on the 11th of March, 1841, and is supposed to have disappeared on or about the second or third night after her departure.

Then there is the American steam ship *Pacific*, of which it is recorded that "The maritime prefect of Brest has transmitted to the minister secretary of state for the navy and the colonies, a note written with pencil in English, and which was enclosed in a glass bottle found on the 14th of September, 1857, on the strand of Melun, in the syndicate of Prospedor, department of the Finisterre—'Steam-ship *Pacific*, Eldridge (master) commander, Smith passenger—Steam-ship *Pacific* run between two icebergs, all hands lost, on the 1st of April, 1856—just going down, 2 p.m.' The word April is written over a word effaced, for the author of the note had first commenced with a capital M as if about to write March.—*Moniteur*."

Then there is the *Marlborough*, which sailed from the Tyne to China on her first voyage, and reported in the "Manchester Guardian" of April last as being well manned and commanded, and having been ten months without any report of her, "nearly all hope of ship, crew, and cargo has been abandoned."

I will only particularize one other case taken from the "Northern Ensign":—"On Wednesday a bottle was found cast ashore on the beach at Callyburn, three miles east of Brora, Sutherlandshire, which, when opened, was found to contain a slip of paper, with the following written in pencil, and in an excellent hand. 'Off Clyth Head, July 10, 1858. Running with bare poles; death staring us in the face; mate washed overboard; Lord have mercy on us. Ship *Mary Jane*, of Glasgow; James Dryburg, master.' On the reverse side was written 'If this is picked up by any person, they will give it to Jeffrey Campbell, Glasgow, owner.' The paper was duly forwarded to Mr. Campbell, by Mr. Sutherland, postmaster, Brora, as directed.

Now to remedy in some measure the dreadful suspense into which multitudes are thrown by such dire events, and to furnish it may be the mournful satisfaction to surviving friends and others interested in such calamities by knowing the last that befel the fated ship, a benevolent gentleman of my neighbourhood, John Gresham, Esq., J.L., alderman of Hull, suggested an idea which he has commissioned me to communicate to the British Association, and if, by his plan, a record of losses at sea may be made, giving a more certain chance at some time or other of their becoming known, he will feel himself amply repaid for any thought he may have devoted to the subject.

Having taken Mr. Gresham's suggestion into consideration, I have to state that he proposes that every sea-going ship, of whatever description, and particularly those carrying passengers, shall be provided with one or more copper buoys, bearing the name of the vessel, and the port or place to which she belongs; that they shall also have an Admiralty mark, and a Board of Trade number, so that even if only the number were found upon it, it would be known to what ship or vessel it had belonged, supposing it contained no record within it.

The Gresham Record Buoy (for that I think would be a good name by which to designate it) (illustrated Plate cxxxv., Fig. 9) would be provided with a chamber and small spring valve in the upper part, made to open outwards, and capable of resisting any ordinary pressure. Within this hollow space or chamber it is proposed to insert a slip of paper or card, or any other document, and even property if made large enough, when all hope of safety and rescue shall fail, and at the final sinking or breaking up of the ship, the buoy would float off, with the probability of being picked up at some time.

The record buoy is intended to be made of strong copper, of sufficient size to be applicable to the purpose, painted as indicated in the illustration, in bright red and white stripes, and fitted with a small bell and flag on the upper part.

There are several advantages to be derived from the use of this buoy, and amongst others, three of importance, viz., firstly the mournful satisfaction to surviving friends and relations of being informed of what has befallen the ship and crew. Secondly, satisfaction to insurance companies and the insured, that the ship and cargo are really and for ever lost. And, thirdly, the light which may be thrown on science, as such records would probably explain the cause of accidents, and the circumstances attending them—for instance whether owing to the build and want of strength in the ship, failure in machinery (in case of a steam vessel), or having struck on an iceberg or stranded on a rock.

In case also of imminent danger to a ship, these or similar buoys might be set afloat with the chance of being picked up, containing a description of their situation and danger, thereby giving a chance of relief.

Allusion has been made to glass bottles, which have been used in several instances communicating loss, and the scheme before us is the same in principle, but having advantages which cannot be possessed in bottles, both as to efficiency and marking and numbering, and while glass bottles would be broken by the contact of rocks and other hard substances, the buoy in question would bear a considerable amount of rough usage before it would be entirely destroyed.

A reward should be offered to any one finding the buoys and at once reporting the same.

The author of this paper is greatly indebted to Captain Brown, R.N., Registrar General of Mercantile Shipping, for many important statistics.

A HAND HELIOSTAT, FOR THE PURPOSE OF FLASHING SUN SIGNALS FROM ON BOARD SHIP, OR ON LAND, IN SUNNY CLIMATES.

Section G.

By Francis Galton, F.R.G.S.

A flash of sunlight from a looking-glass, of a few inches in the side, can be seen further than any terrestrial object whatever; and the instrument about to be described shows how this remarkable power may be utilised for the purposes of telegraphy. Heliostats are used in all Government surveys; their visibility is well known, both in clear weather and also in hazy atmosphere, and their utility is recognized in requiring no "sky line;" they were habitually employed by the Russians for telegraphic purposes during the late Crimean war, but all heliostats that have been hitherto used have been fixtures of large dimensions. Commonly a shaded screen is erected with an aperture in it, at many yards' distance from the signaller, who stationed himself in such a position that when he could see the play of his flash about the hole in the screen, he might be sure that some of the rays which passed through it would be visible at the distant station. At other times a polished ring was used for the same purpose as the screen, but the principle was the same. The present instrument dispenses with all fixtures; it is more portable than a ship's telescope, and as manageable as a ship's quadrant, and it can be made by any carpenter who possesses a convex spectacle lens of short focus, and a piece of the best kind of looking-glass. The glass attached to the heliostat is about 3 in. by $4\frac{1}{4}$ in., and therefore calculated to be seen at distances, which may be gathered from the fact that a mirror, one inch square, is perfectly visible to the naked eye, in somewhat hazy but sunny weather, at the distance of seven miles and a half, and that it shows as a brilliant and glistering star at two miles.

Before describing the principle and action of the hand heliostat, it will be necessary to explain, in a few words, the peculiar characteristic of the reflection of the sun's rays from a plane mirror. If we take a small square looking-glass, and throw its flash upon a wall two or three feet off, the shape of the flash will be little different from that of the mirror itself, seen in perspective; but if we direct it on an object three or four yards off, the angles of the flash will appear decidedly rounded; at fifteen or twenty yards it will appear fairly circular; and if we manage to see it at fifty or 100 yards (which can only be effected by selecting some object to throw it on that is naturally of a light colour, but lying under a dark shade), it will appear like a mock fan, of almost identically the same shape and size as the fan itself; and for all greater distances the appearance remains the same. In fact, whatever may be the shape or size of the mirror, and whatever the irregularity of the distant objects on which its flash may be thrown, the shape and size of that flash, if it could be seen by the signaller, would always appear to him as exactly equal to that of the sun. The flash forms a cone, having the mirror and the signaller's eye at its blunted apex, and having its vertical angle equal to that subtended by the sun's diameter. Now if the eye could trace the appearance of the mock sun on distant objects, it would be perfectly easy for a person holding a looking glass to direct its flash upon them when and where he desired; but the hand heliostat requires no mock sun to aid the direction of its flashes, itself supplies the appearance of a sun, which exactly overlies the very spot where the mock sun would be seen, supposing it became visible; and by bringing this image over the distant station in the fashion of a sextant observation, the flash is directed thither, just as certainly as if it had been the mock sun itself which had guided the signaller's aim.

The principle of the instrument is exceedingly simple; Fig. 11, Plate cxxxv., shows the instrument opened so as to exhibit its construction; Fig. 12 is intended to explain it; L, N, is a convex lens, or rather a piece cut out of one, as shown in Fig. 13, having a screen S attached to it, and adjusted to its exact focal distance. M is the mirror, seen in section in Fig. 12 (such as it would be, if a section were made of the instrument, when in position). E is the position of the signaller's eye.

It will be observed that the mirror flashes a few of its rays on the lens and the rest of them out into space, the eye looks partly through the lens and partly free of it, the size of the pupil of the eye admitting readily of this. Now consider the rays represented in Fig. 12, which are supposed to be those proceeding from some one single point of the sun's disc; those that go into space proceed in parallel lines towards some "vanishing point," V. Those that impinge on the lens are conveyed, by its means, to some point, K, on its surface. Now, of the rays that are radiated in all directions from the bright speck at K, those which impinge on the lower part of the lens will be reduced by means of it back again to an exact parallelism with the rays that first left the mirror. Consequently, E will see them as proceeding from the vanishing point, V; and, by looking partly free of the lens, will be able to refer V to that one of the distant objects of the landscape with which it may happen to coincide. Now what is true for any one point on the sun's surface is true for every point, and, consequently, instead of a speck of light being seen at K, a disc is seen there; and a disc it is of exactly the same shape and size as the sun itself; and this is the image which we have spoken of as overlaying the area of the mirror's flash with the utmost precision. All the signaller has to do is to bring this image down upon the distant ship or station; he must turn the mirror on its axis, and rotate the instrument until he catches the sun's disc on the lens, and, when he has done so, an inclination of the hand will supply the necessary contact. Each coutact makes a flash, and by using three groups of flashes, consisting of one, two, or three flashes in each group, any letter can be made; by using two groups any numeral. The mirror should be of the best plate glass, or there will be an irregularity in the flash; a common looking-glass is worthless for intelligible signalling. It is very important that the two sides of the glass should be ground parallel to one another, with reasonable accuracy, else each surface will reflect its mock sun in a different direction, and they will form two separate and overlapping discs, of which only the overlapped part is fully illuminated. When signals are made the flash should be allowed to dwell a quarter of a second on the distant station, a rapid flash is scarcely visible. The brilliancy of the image should be toned down to a moderate degree, by pushing up the slide D; it diminishes the pencil of rays that reach the lens. Care must be taken that neither the hand nor the head interfere with the light that falls on or off the mirror. It is perfectly easy to flash to within 12° of a point exactly opposite to the sun, by holding the tube a short distance from the eye. The utmost care should be taken in the adjustment of the screen S; it is the only adjustment in the instrument, and should be made with the greatest precision, by comparing the precision of the image of the sun with that of the mock sun as watched upon a well selected and distinct white screen, properly shaded. S must be pushed backwards or forwards till the images coincide exactly, and then fixed firmly and permanently.

ON THE APPLICATION OF HYDRAULIC POWER TO BLOWING THE BELLOWS OF THE LEEDS TOWN HALL ORGAN.

(Illustrated by Plate cxxxv.)

Section G.

By Dance Joy.

Hitherto organs have been only blown by manual power, and this necessity has been a great bar to their more general introduction. For chamber organs, the inconvenience of a man to blow is scarcely less than the annoyance of the performer blowing for himself, which can only be done in the case of very small instruments; and for churches and public buildings, where very large instruments are employed, the difficulty is greatly increased—added to this, the prevailing tendency of the builders, both in England and on the continent, is to increase the wind pressure, and so from a $2\frac{1}{2}$ in. column of water, it has risen to 5 in., and in some parts of large organs to 12 in. This again increases the difficulty by requiring a greatly increased power to provide wind at the increased pressure. Thus the grandest musical instrument, combining in itself the effects for the most part of a whole orchestra, is dependent upon a troublesome need, which every performer has long complained of, but until now none have overcome. The difficulty has been attempted to be overcome, and some few years ago an organ was blown in London by clockwork, moved by a ponderous weight—of course in any large organ this method must obviously fail. Water has also been used, and there are one or two cases on record of its application, details of which, for want of time, the writer has not been able to furnish; but the application was limited to the single cases. The last and most feasible is an engine designed and made by a Glasgow gentleman, and now the property of Messrs. Gray and Davison, of London; but this, from its great expense, has not been adopted.

The writer's attention was first directed to the subject three years ago, by a request of his brother, Mr. Walker Joy, who has a large chamber organ of 40 stops, to design any motive power to render the organ independent and as available as a piano. A moment's consideration at once pointed to water pressure as the only available source of power, especially as every town of any importance is now provided with its waterworks, maintaining a constant supply at a pressure. The proposition was now analysed thus: first, what is required? second, how to meet that requirement. To work the feeders of an organ a reciprocating motion *alone* is required; but it must be capable of perfect regulation down to an infinitesimally slow speed, and without impairing its certainty of action at that slow speed; hence it cannot depend upon momentum to pass the dead points at the top and bottom of the stroke, as in a steam engine, and for simplicity it must only consist of one cylinder. It must also be absolutely independent of attention or lubrication, and be always ready for use. The first experiment was made with a single cylinder similar to a steam-engine cylinder, with a four-way cock, as valve, to admit the water to the top and bottom of the cylinder. It is clear that if this valve was moved directly from the piston-rod, as in the old Watt's steam engine, that when moving slowly, the piston would carry the valve until it covered all the ports, and the power being then shut off, motion would cease; to avoid this the four-way cock or valve was arranged not to move until the completion of the stroke of the piston, when it was pulled over by a spring; the movement of the valve was thus made dependent upon the piston arriving at a certain point in its stroke, and not upon its continued movement after that point. The engine would now work at any speed without sticking at the end of the stroke, but from the rapidity with which the spring pulled the cock or valve round at each end of the stroke, when moving quickly, a severe shock from the change of direction of the moving column of water was produced; this shock was removed by causing the lever moving the four-way cock to compress by its action a reservoir of air which was allowed to escape slowly, hence retarding its action, and gradually turning the cock and changing the direction of the moving column of water. Theoretically, the difficulties were now overcome, and the engine for a time worked satisfactorily, but practically it was found most difficult to keep the adjustments so correct as to maintain certain and steady action. At this point the engine was seen by an organ-builder of this town, who suggested moving the valve by what organ-builders technically called a "pneumatic lever," the valve of which lever was to be worked by the piston-rod of the engine. The old arrangement of springs, &c., was stripped, and the pneumatic lever applied.

It consists of a small pair of bellows like a "concertina," with a loose middle leaf, the two outer ones being fixed; by a small valve, wind is admitted from the wind reservoir of the organ, alternately at each side of this loose leaf, which, by its attachment to the four-way cock of the engine. gives it the desired motion. This produced a very equal aud steady motion for the valve, and several engines were made and worked for some time on this principle, under the name of "Hydro-Pneumatic Engines."

It was about this time that the Leeds Town Council invited competition for plans for the large organ for the Town Hall, and this method of blowing was proposed, and plans of it forwarded. The engine, however, was found to give no permanent certainty of action, as the varying friction of the four-way cock, and its need of delicate adjustment, was a source of frequent trouble. It was also found impossible to keep it properly lubricated, and hence the lateral pressure upon it soon destroyed its figure.

To meet these difficulties the writer altered the form of the engine entirely, and keeping only the cylinder A, see plate cxxxv., attached ports and valve similar to those of a locomotive engine, B B being the inlet ports, and C the exhaust port, the valve sliding over a three port face, as shown at D, Fig. 5. This valve is moved by its spindle or guide being enlarged at each end, with a small piston E E, working in a corresponding cylinder, F F. These cylinders receive water pressure alternately direct from the same source as the engine itself, through a small four-way cock, I, Fig. 2, which, by the lever J, is worked from the piston rod. The engine again, in form, gave a still more perfect result, and by the introduction of a screw, L, Fig. 16, into the outlet port of the four-way cock, 5, that port could be diminished at pleasure, and thus the two pistons, E E, carrying with them the valve D, retarded in their motion, and the engine thus fitted to work under any pressure of water.

For some time the engine continued to work perfectly, but shortly difficulty was experienced in lubricating the valve upon its face, requiring attention, varying from once per month to once in three to six months. Various metals were tried relatively for the valve and face, but all, after a time, squeezed out the lubricating material from between them and cut into each other—glass was tried with no better success. Lastly, a lignumvitæ valve was put in; this stood every test, and, though taking a little more power to drive when originally put in, it was found to need no lubrication of any kind, the water acting in place, and, after being in use for some time, showed less wear than any of the metal valves, aud retained a greasy slime apparently permeating in its substance.

The peculiarities of the engine as it now stands are:—

1st. A machine giving out a reciprocating motion by the pressure of a non-elastic fluid, and capable of being regulated to the lowest possible speed without the possibility of failing at the return stroke, that return stroke depending upon a movement (that of the small four-way cock) completed by the previous stroke.

2nd. The adaptability of this machine to work under any pressure of the afore-named non-elastic fluid, entirely free from the shocks usually attending such machines, from the necessity of suddenly changing the direction of the moving column, which may be changed as slowly as requisite by retarding the valve D, on diminishing the outlet at L.

3rd. The entire independence of attention or lubrication.

In this form many of the engines have been at work for twelve to fifteen months, giving not the slightest trouble, and requiring neither examination nor lubrication.

It is by five of these engines that the large organ in the Leeds Town-hall is blown; they are calculated to be able to supply 50 cubic feet of air per second at a pressure equal to a column of water of 6 in.; and when working at full speed develope a power equal to about 8-horse, as calculated by Watt's rule.

ON AN EXPANDING PULLEY.

By Mr. JAMES COOMBE, of Belfast.

Section G.

A PRETTY correct idea of this pulley may be formed by supposing two cones cut with radial spaces alternating with solid parts, so that the solid parts in one may slide freely into correspouding spaces in the other, in the direction of a common axis. The sizes of these radial sections are regulated so that when the two cones are put together they form a grooved or V pulley, the diameter of which varies according to the position which the cones occupy with regard to each other.

This will be seen ou reference to the accompanying illustration. It will also be seen that any desired amount of variation in size may be got, and this without involving the necessity of occupying a large space. This change in size is made by pressing the one into the other, which can easily be done whether the pulley be in motion or at rest. The value of the property of giving readily any amount of change in size, will be made evident by a comparison of the results obtainable by a pair of common cones and a pair of expanders, of similar dimensions, and giving the same extremes of speeds.

A range from one to four ft. in diameter (or more if necessary), is easily obtainable in the expanders, and supposing the one which drives to have speed of eighty revolutions per minute, and that it be set at 4 in. diameter, and the one which is driven to be set at 16 in. diameter (the corresponding position), the speed of the latter will be one-fourth of eighty, or twenty revolutions per minute. When the driver is changed to 16 in. diameter, and the driven to 4 in., the speed of the driven shaft will be increased to 320 revolutions per minute.

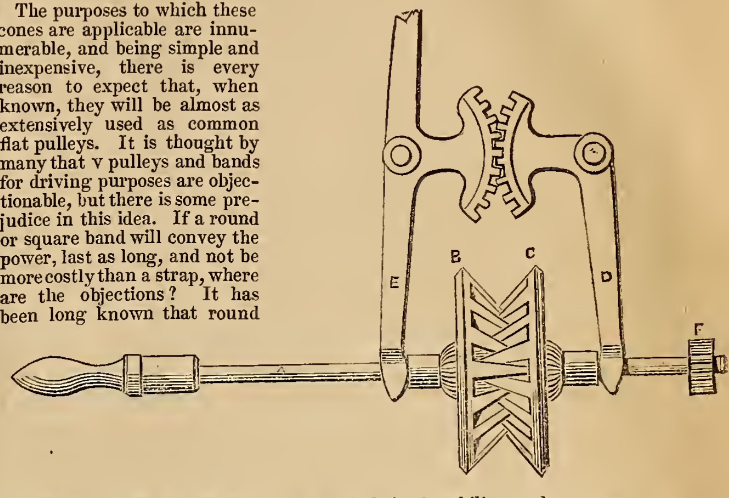
The changes between these extremes (twenty and 320) may be of any extent or per centage on the speed, and they can be made as gradually as is desired without stopping.

For comparison with this, take a pair of common cones having the same extreme diameters, and having steps of 2 in., which is not more than usual. When the driving strap is changed from the steps on the cones, which give the lowest speed (that is, twenty revolutions per minute) to the next steps, which is the smallest change that can be made, the speed of the driven is increased to thirty-four revolutions per minute, that is, 70 per cent. on the former speed. The change to the next steps makes the speed of the driven fifty-three, and the increase here is 56 per cent. The third change increases it to eighty, or 51 per cent. The next to 120, an increase of 50 per cent. Then to 186 by an increase of 55 per cent. And, lastly, to 320 by an increase of 72 per cent. All these changes in speed are great, and although in practice mechanics have become accustomed to them, and do not think of the loss, it is quite clear that a great waste of time must result from not being able to get smaller changes readily. For instance, suppose that a lathe or boring machine has a piece of work in it of a diameter that would require a speed between any of the speeds which the steps of the common cones give, but which will not bear the whole step, it is quite clear that in this case a loss of time and work equal to 50 or 60 per cent. may take place. To get over the difficulty attending the use of common cones, some tool-makers use two pairs of driving pulleys on the counter shaft, which of course doubles the range of the cones, but this is a cumbrous arrangement, and is still very far from giving what is necessary or desirable. There are many machines in which a variation of speed is desirable, and would be used if it could be got readily; but there is often such a loss of time involved in making a change that very much slower speeds are used rather than take the trouble or incur the delay of making that change. The common cones referred to are not by any means an extreme case; on the contrary it is quite common to make the steps even greater, and if the number of steps be less, and the extent of the range smaller, there is of course a corresponding diminution in the adaptability of the machine to different purposes.

The expanding pulley was first brought out for the purpose of giving the varying motion to the bobbins in flax and tow-roving frames, to which it is applicable with great advantage, from the accuracy of its action and the small space which it occupies. By its use a very simple and correctly working machine is got, capable of making bobbins either in the ordinary way or in cops. It is equally applicable to the heaviest and the lightest frames.

A very simple mode of applying a stretching pulley is to make the pulley, which does not vary with two grooves or V's, and pass the baud twice round it, putting the expander in one fold, and the stretching pulley in the other. These arrangements are applicable to many other purposes. Where two expanders are used, one to drive the other, it is not necessary to have any stretching pulley, but simply to connect one or both sides of each pulley with levers, so that they may be moved simultaneously as required.

In the accompanying illustration this arrangement, applied to a cop machine, is shown—A being the shaft, which is actuated by a lever handle at one end; and the one-half of the cone pulley, B, and the other half, C, slide on a feather therein, and are turned thereby. D and E are two levers, having forked ends, by which the alteration of the position of the two halves, B and C, of the cone are regulated and the diameter varied; F being a pinion upon the shaft spindle, A.



The purposes to which these cones are applicable are innumerable, and being simple and inexpensive, there is every reason to expect that, when known, they will be almost as extensively used as common flat pulleys. It is thought by many that V pulleys and bands for driving purposes are objectionable, but there is some prejudice in this idea. If a round or square band will convey the power, last as long, and not be more costly than a strap, where are the objections? It has been long known that round gut bands can convey great power, and their durability and economy soon speak for themselves. There is a gut band here which was in constant use on a sixty spindle roving-frame for seventeen months, and it is as good now as when it was put on, or nearly so. In such a frame, made in the ordinary way with two cones, a strap $2\frac{1}{2}$ in. or 3 in. broad would be used.

From the great range in size which can be got with these pulleys, and the keen bite which the bands take, they are exceedingly applicable to tools of all kinds.

As an instance, a drilliug machiue made by Messrs. Buckton and Co., in the Exhibition of Local Industry, now open in Leeds, may be referred to, in which, by means of a pair of these pulleys, which can be changed from 4 in. to 16 in. diameter, any variation of speed can be got at once from 20 to 320 revolutions per miuute, or other range in a like proportion. In this machine the usual bevel wheels are made two to one in place of being equal in size, and it has no other gearing; it will, however, do nearly as great a range of work as double-geared machines of similar size. The cost is less, and the facility of change much greater.

To lathes it is equally applicable, and its peculiar adaptation to those for surfacing will be obvious. A governor driven by it can be made to regulate an engine or water-wheel at any desired speed without stop or trouble. It is also extremely well adapted to give the varying speeds required in weaving machines, such as dressing, warping, and winding machines, and for positive giving out and taking up motions iu looms. These pulleys have now been in use extensively for about two years for roving frames, and can be spoken of with confidence as to their performance and value. For most purposes a round band answers very well, but where a considerable power is wanted to be transmitted, bands formed of two or more thicknesses of leather can be used. In conclusion, it may be stated that the liability to accidents is very much diminished, as it is not necessary for the attendant to touch the band while changing the speed.

ON THE CONSTRUCTION OF FIXEO AND FLOATING BATTERIES FOR COAST DEFENCES.

(Illustrated by Plate cxxxv. Figs. 2, 3, and 4.)

Section G.

By GEORGE RENNIE, Esq., C.E., F.R.S.

THE object of the present paper is to bring before the section the question of the use of iron plates for the protection of fixed and floating batteries in the defence of our coasts and seaports, and to obtain the opinions of professional and other gentlemen how far or with what probability of success the system may be carried out. It is now some years since that the system of covering the exterior of vessels of war with a defensive armour of plates of iron was proposed by Colonel (now General) Paixhans, of the French artillery, in 1834, at Metz. This he exposed in a work entitled, "Nouvelle Force Maritime," in which he stated that to enable a vessel so plated it required a thickness of several inches to resist a 32 lb. shot; and that from the great weight of the plates it was only applicable to ships of the line, and that at a cost of 600,000 fr., or £24,000. On the commencement of the late Russian war the question of constructing floating batteries was brought before our Government (it is said) by his Majesty the Emperor Louis Napoleon, who had paid great attention to the subject, and who considered that it would very much faci-

litate the operations then about to take plate against the Russian fortresses of Bomarsund, Helsingfors, Sweaborg, and Cronstadt. Vessels of great burden and strength were therefore constructed and covered with massive wrought iron plates of 4 in. and 5 in. in thickness; and many experiments having been previously made by firing at them when attached to butts of timber, both at Woolwich and Portsmouth, the vessels so covered were considered capable of withstanding any battering which might have been delivered to them by the enemy. The results of the few trials which were made by several iron plated batteries by the French at Kinburn in the Crimea were published in the journals of the day. but their success was considered to have been doubtful.

The capture of Bomarsund was principally owing to its investment by a land force—the fire from the naval force having had little effect other than slightly disjointing some of the stones of the granite walls. The iron-plated batteries, were, I believe, not used in the naval attack on Sweaborg.

Many experiments of solid and hollow shot fired from 68 lb. guns mostly, have been made recently at Woolwich and Portsmouth with unfavourable results.

In 1821 some interesting experiments were made by order of the United States Government on seven thick wrought irou plates 5-8ths in. in thickness, fixed to a solid block of wood, and fired at with large guns and different charges, and the results were unfavourable. In 1834, 1849 experiments were made both in England and France on the penetration of iron plates by cannon ball, and which led to the condemnation of iron ships for war purposes.

In 1854 a series of experiments were made also by the United States artillery on the effects of shot fired at a target covered with iron plates set at different angles, by a 32 lb. gun, 56 cwt., and charges of 10lb. of gunpowder. The following were the results :—

Angle of Surface.	Charge.		Deflection of fragments.
10°	10 lb.	Shot broke	$4\frac{1}{2}$°
12°	10 lb.	do.	$17\frac{1}{2}$°
15°	10 lb.	do.	13°
17°	10 lb.	do.	30°
20°	10 lb.	do.	21°
22°	10 lb.	do.	$18\frac{1}{2}$°
25°	4 lb.	do.	$21\frac{1}{2}$°
27°	10 lb.	do. in 4 pieces	$11\frac{1}{4}$°
With $5\frac{5}{8}$ plate against oak target.			
27°	4 lb.	do. in 6 and many smaller	$21\frac{1}{4}$°
30°	10 lb.	do.	
30°	4 lb.	Shot went one-half through the plate and the other half deflected.	

In the American report on coast defences, published in 1852, the following extract is given by Sir Howard Douglas, iu his admirable work on Gunnery, and to whom the author of this paper is indebted for these particulars. It says:—

"So far as the new projectiles are concerned these have, relatively to ships, strengthened fortresses; for hollow shot crumble into fragments, and strike harmless when directed against stone walls. It takes solid shot, and plenty of them, rapidly discharged and concentrated upon and near the spot, to batter walls and make breaches. On the other hand a few 8 in. or 10 in. shells, fired from forts at ships, pass through the sides of any line-of-battle ship into the main or lower deck, and there exploding amidst the dense crowds at the batteries, every fragment multiplies itself into countless splinters of wood and iron; or if a shell enter into the orlop deck, among the men, into the powder magazine, or striking the water line, large, irregular splinters will be torn, leaving openings which will defy all shot plugs."

From what has been said, and from the results of experiments since made at Portsmouth, so prominently noticed by the Earl of Hardwicke in his speech on national defences, recently made at the agricultural meeting at Cambridge, there seems to be no expectation that wrought iron plates of less thickness than five inches will resist the effects of cannon shot, when struck point blank; and that the only probability, therefore, of meeting the difficulty is by inclining or curving the plates, so that they may be used of less thickness. I am aware that the sides of the *Erebus* floating battery were inclined, and that the Russians used inclined plates in three floating batteries of one inch in thickness, with perpendicular plates of five inches in thickness for the parapets. But I have not heard of iron plates being used in curves, although it is now some years since I proposed them for gun-boats. The principles proposed were illustrated by models.

[The foregoing paragraph has been handed to us, slightly altered by Mr. Rennie from the concluding one of his paper read at Leeds. We have appended to the paper illustrations of the various forms of batteries proposed by Mr. Rennie, which illustrations have been supplied to us by him. Fig. 2, Plate cxxxv, shows a battery having curved sides and similar to the model exhibited at Leeds, at the reading of the paper. The shapes of these batteries are proposed both for land and sea purposes; in the former case with the addition of a dry ditch round the base. Fig. 3, Plate cxxxv, is a cross section of a screw frigate. Fig. 4 shows one form of floating battery incased with iron plates for coast defences.]

SOME MODERN APPLIANCES FOR RAISING WATER.

(Illustrated by Fig. 1, Plate cxxxv.)

By W. O. Carrett, Sun Foundry, Leeds.

Mechanical science and the Times are rapidly progressing, as certain as cause and effect. Next, perhaps, to the greatest of modern inventions, the steam engine, must rank the "pump" in its various useful phases of quiet underworking, helping human progress in its countless manifestations, and bringing to light hidden sources of power. Our lauds want draining, their crops invigorating, and our corn-fields keeping dry, for water will gravitate, and we must keep pumping. If steam be to occupy the place of human power, this water must be forced into our boilers; and if comfort and health are to be in our dwellings it must be forced thither too. From the great engine at Haarlem down to the common domestic pump, there are in existence a great variety of appliances—such as suction and force pumps, centrifugal and archimedean pumps, spray pumps, percussion pumps, wheel pumps, chain pumps, rotary, vibratory, and others. The two varieties here claiming attention combine both steam engine and pumps in direct action,—the moving power and work to be done associated agreeably together, hand-in-hand, to administer to our daily wants and perform the drudgery of life's necessities: leaving us more time to think and act.

Drawings were exhibited of several varieties of the combinations of the steam engine and pump; in each case the steam cylinder is over and in direct communication with the pump beneath. A comparatively slight transposition will, of course, arrange these horizontally, if required. The first drawing was of a steam pump of the high pressure transportable class, having a fly-wheel, &c. The second, of a modification of this, for special cases, where lightness and portability are required; while the third was of a further application of the first named with the connecting-rod and slide bar modified. The accompanying illustration is a section of a compound high and low pressure condensing steam engine, of much larger proportions than those above referred to, and capable of raising 6,625 gallons, 40 ft. high per minute. With reference to the plans first referred to, the object sought to be attained is simplicity and durability of parts, a quiet and noiseless action, and, as far as possible, a superior duty effected with a minimum expenditure of power, and a reduced first cost.

One of the peculiar features to be observed in these transportable pumps is the application of a suctional and compressive air vessel in close proximity with the clacks, by which they are able to fetch the water from any distance (of course within certain limits determined by the friction in the pipes) or from any depth not exceeding 29 ft., and to force it any required height or distance. The ordinary pump cannot do this, unless at a miserably low speed, so as to give the water time to be stopped and started throughout the entire range of the pipes, at each alternate stroke. Three common pumps, with their threefold accompaniments of buckets and clacks, driven by a three-throw crank, will do this at a cost, with a sacrifice of all simplicity and direct action. Water being a non-elastic medium, the resistance of its inertia being rapidly started into motion, and the impelling influence of its momentum when in motion, have caused countless failures and disappointments in various pumping schemes. To get an ample supply of water quietly and freely into and out of the pump is not always as easy as it is desirable. The circumstances uuder which pumps have to work are often so varied, and the necessity to have them simple and effective is so great, that it becomes an important desideratum to have a pump and its engiue combined in one machine that will meet all emergencies. Distance is a great obstacle to the action of common pumps. Water is often required to be fetched and forced along and up a considerable range of suctional and delivery pipes. Since, therefore, water will not be stopped and started into motion in immediate accordance with the demands of a single-acting pump, but will testify its natural objection to be hurried iu the form of a series of shocks and strains which soon impair the best clacks that can be applied—since, further, a double action pump is little if any better—nor are all of us disposed to sacrifice direct action, or to invest unnecessary capital and care upou a complicated arrangement of these pumps, or to be content with one large one driven at an inglorious snail's pace, we must therefore adopt some simple and effective expedient which is neither cumbersome, costly, nor complicated. This, to the author's best judgment, cousists in air-vessel appliances which enable pumps to work quietly and successfully at a speed of, say, 110 or more ft. per minute. A continuous stream in the pipes is, therefore, essentially necessary. Perhaps one practical case in point may show this clear enough for our present object. Some years since the writer was called to inspect a pair of pumps (single-action plunger-pumps of considerable size driven simultaneous and opposite) constructed to force about 150 ft. high, and draw the water, say 30 ft. distance, and from a depth of 15 to 20 ft. When the pumps were started beyond a disreputably slow speed, a series of percussive shocks commenced in the pipes and pumps which threatened total destruction to all the parts, to say nothing of the additional power absorbed. An air vessel was suggested and applied to the delivery side of the pumps, but this only changed the character of the evil. At each up-stroke the water could not follow the ram for want of time to set the suctional column in motion, and when the down stroke commenced the inlet current was theu about at full speed, and actually accumulated to 5 lb. and 7 lb. pressure in the suction pipes. Another air vessel close to the inlet of pump being provided, all difficulties were at once removed, and the motion became at once noiseless and effective, even at the fourfold speed. So simple was the remedy for so great an evil, and yet there are hundreds of similar constructions to be met with where the pump and water are thus combating together, at an enormous sacrifice both of plant and power.

Desiring to account for this percussive action of the inertia or momentum of water, Smeaton, whose birth-place and remains are but a few miles from this town (Leeds), invented his ingenious hydraulic ram, in which the gravitating tendency of a body of water forces a portion of itself to a greater height than

that whence the source is obtained; and we might further illustrate this law by a percussive action pump, which would raise the water from a greater depth than the usual atmospheric limit of 32 ft.

In reference to the drawings exhibited, where a good single-action plunger pump does all that is required: in the three plans just referred to, the steam cylinder is vertical, and placed over the pump, and the piston-rod is in direct communication with the ram. Between these two, and supported by suitable standards, is the fly-wheel, which allows the steam to be worked expansively, and keeps up a uniformity of power. In two of these examples the reciprocating is converted into a rotating motion by the slotted frame movement, which forms part of the piston-rod, and partakes of its motion; while, in the third, this is otherwise arranged to have the slotted frame curved to the radius of the connecting-rods, so as not to touch or slide upon the crank-shaft which revolves through it. The purpose of this will be obvious. Thus, the requisite part of a complete steam-engine are provided which can be used to drive machinery, and the pump, if requisite, can be disconnected, the whole requiring no foundation or fixing, save the attachment of the steam and water pipes.

The base portion of the first and third plans referred to forms the pump and its accompanying air vessels for suction and delivery, and the water enters and leaves the requisite inlet and outlet of base in one continuous stream.

In the second plan these air vessels form columns and standards to support the cylinder and carry the fly-wheel. Compactness is here effected, which is essential with extreme lightness when the apparatus has to be transported from place to place.

I would next proceed to call attention to another arrangement of water lift steam pump, of a much larger construction, in which the water to be raised is not enclosed in pipes, and there is no rotative or fly-wheel medium employed.

The engine shown in Fig 1, Plate cxxxv., is working in Holland, and was constructed by Messrs. Carrett, Marshall, and Co, of Leeds, to raise 6,625 gallons 10 ft. high per minute, and designed for drainage purposes, but can also be modified for greater depths. The steam cylinder is 25 in. diameter, and the pumps 5 ft. diameter. If the cylinder here shown were merely single-acting, receiving high pressure steam under the piston, and thus effecting the up-stroke, and then throttling it out at a considerable pressure into the atmosphere, the arrangement would be one of pretty general adoption, where waste of fuel is no object. In the designing of this engine fuel *was* an object, as it ought to be everywhere, where common sense is not too scarce. In an improved direct action water lift the steam is used twice over, or developes its expansive power at two periods before it is suffered to escape into the condenser. A is the cylinder fitted with a piston in the usual manner; but underneath and attached to this piston is a trunk B turned up and passing through the bottom of the cylinder, and working steam-tight inside another cylinder C, which in this instance is made into the air-pump. From the bottom of this air-pump a further prolongation of the rod D communicates motion to the bucket of pump (which in special cases can be again substituted by a ram.) Hence, from this disposition of parts, the effective area of the underside of the piston on which the steam is first admitted from the boiler is annular, while the upper side of such piston has the full area exposed. The position of the parts, as here illustrated, are those when the pump is making a down-stroke, the partially expanded steam from the under-side of the piston is being re-admitted upon the upper side. E is the condenser, F and G the valves of air-pump, H the hot well, I a cross head or piston, to which the balance chains are attached, over the wheels J, to the weight K; L is the pump bucket, M the bottom valve of the same; N is the warming apparatus to heat feed water, through which waste steam passes on its way to condenser; O is the auxiliary engine for working slide valves. The steam first enters from the boiler at, say, 50 lb. pressure upon the annular area of piston, at the same time that the vacuum operates upon the full area or upper side; the joint action of these produce the up-stroke; the steam has now effected but half its duty, and not having parted with sufficient of its expansive power is in an unfit state to be discharged into the condenser. Hence, the necessity to re-admit it upon a much larger area of piston, and there expand it down to the atmospheric pressure, or as much lower as is deemed advisable—this being regulated by the expansion valve and the amount of balance applied to the point K.

Thus is effected in one cylinder what, in the ordinary compound engine, is done in two, while a ready form of direct action air-pump is furnished without any radius bar or beam. The remaining power thus developed by the second expansion of the steam is absorbed by raising the balance-weights, as well as by the resistance of the water to the bucket's descent. An adjustment of these weights regulates the speed of the down stroke, and the period of rest at its termination.

The slide-valve is a modification of an every day appliance, with an additional slide in the back and an adjustable eccentric to regulate the period of admission. This valve is driven by an auxiliary engine, which at the same time works the feed-pump of boilers, thus dispensing with the usual Cornish tappet-and-plug motion, and affording means of supplying boilers when the large engine is at rest. The multitubular chamber, N, receives the feed-water in its way from the pump, and thus heats it to a far higher temperature than that of the hot well, so that it enters the boilers close upon boiling point. The lift pump is of simple form. The bucket and clack have each six arms, terminating in a central boss. Upon the circumference, and supported by these arms, are three annular cast-iron perforated plates, and upon these again are three india rubber rings, of similar form. Each ring rises a step above the one beneath, affording a free delivery to the water; the whole being held down by the central bolt. The space, P, above top of pump is enclosed to confine the discharge water to its destined course, and terminating upwards at the required height. In the outlet watercourse there are sluice-boards, by which the out-water can be kept back if entrance be required to the interior of the pump.

As the height of delivery and depth of suction vary according to state of rains, the pump when working at its lowest head is merely a lift pump, but when the height of discharge increases it then acts as a lift and force pump, and requires a simple adjustment of the slide and balance weights to suit the altered circumstances. In the ordinary dash-wheel appliances for land drainage, the out-water is often so high as to impair the effective duty of wheel, and when the inlet is unusually low the slip is very serious. The pump arrangement here shown prevents this, and works advantageous at all variations of water level. The same could be easily constructed of 10 ft. diameter for a fivefold amount, or a pair of engines and pumps could be applied working opposite and simultaneous, each balancing the other: the amount of foundation in these engines is reduced to a minimum, and is of the simplest form, the whole apparatus being self-contained, and placed immediately over the work to be done.

INSTITUTION OF CIVIL ENGINEERS.

November 9, 1858.

George P. Bidder, Esq., Vice-President, in the Chair.

The first Meeting of the Session 1858-59 was occupied by receiving a "Description of the Line and Works of the Lisbon and Santarem Railway," by Mr. J. S. Valentine, M. Inst. C.E.

The Author commenced by alluding to the great deficiency, or almost total absence, of all facilities for internal communication in Portugal; stating that prior to 1853 no roads existed over which wheeled carriages with springs could travel, with the exception of that between Lisbon and Cintra, a distance of 18 miles, and from Lisbon towards the north, for about 25 miles, both of which were made within a very recent period. Since that year some improvements had been effected, particularly on the highway between Lisbon and Coimbra, on the road to Oporto, a distance of about 100 miles. Four-horse mail coaches, built after an English model, had been introduced on this line, from Carregado, the present terminal station, northward, of the Railway described in the Paper, and Coimbra. Notwithstanding these partial improvements, there were still many thousand acres of land lying unproductive, owing to the want of roads, and the consequent cost of conveying the produce to market, which could only be effected, in many cases, by transporting it, at great cost, on the backs of mules.

The Author then proceeded to remark, that railways in Portugal were entirely under the control and protection of the Government; the method of granting concessions, as well as the general supervision exercised over the works during construction, being similar to the French system. The ruinous competition, and the costly Parliamentary contests, the result of the English system, were therefore avoided; but, on the other hand, the constant interference of the Government officers with the practical execution of the works, as well as that which might be apprehended in the working of the traffic, was attended with many and grave disadvantages, of which the Author narrated several striking instances. The mode of granting a concession for a railway was then described, —the Government exercising its control over all public works, by means of a Council of State, called "The Ministry of Public Works and Mines." When the project originated with the Government, a programme, or specification, was issued by the Minister of the Interior, inviting proposals, up to a given period, from those who might be willing to tender for the concession. The principal points in this programme were then detailed, upon which a "Provisional Concession" was granted, the "Definitive Concession" being delayed, until detailed drawings and specifications had been prepared and approved. The concession was then submitted to the Cortes, and subsequently had to receive the Royal assent. There was a slight difference in the mode of proceeding, when the project originated with a private individual, or a company. In this case the proposal which was made, was published, and the concession was put up to public auction. If more advantageous terms were offered than by the original projector, and if the latter declined to take it upon these improved terms, then the concession was granted to the party offering them. Before the operations were commenced, the Government appointed one or more fiscal engineers to superintend the works, and, in addition, it was necessary to obtain official sanction for every design, and until a decree, called a "Portaria," appeared in the Government *Gazette*, no work could be proceeded with, except at the risk of its being afterwards condemned. This system was most objectionable, inasmuch as it fettered the freedom of action of the engineer, on whom the responsibility in reality rested.

It appeared that, up to the present time, four concessions had been granted, for a period of 99 years, for railways in Portugal, the terms of which varied considerably, but all had either received a guarantee of interest upon the capital, or a subsidy, or other privileges. The first concession was for the railway described in this paper, which had a minimum interest, guaranteed by the State, of 6 per cent. per annum, for fifty years, with an additional half per cent. to form a sinking fund, and, on the completion of the line, a bonus of 2 per cent. on the capital was to have been paid to the *concessionaires*. This concession had subsequently been cancelled, and the line was now included in that for the railway from Lisbon to Oporto. The second concession was for a railway south of the Tagus, from Bareiro to Vendas Novas and St. Ubes. It was given to a Portuguese company, with a subsidy of about £1,700 per kilometre, a free grant of all the timber required in the works, and of the Government lands over which it might pass. The third concession was for a line from Lisbon to Cintra, with the privilege of constructing docks at Lisbon. This was granted to a French company, without either a guarantee of interest or a subsidy; but a large quantity of land at Lisbon, which the company proposed to reclaim from the Tagus, was ceded to it. The fourth concession, for a railway from Lisbon to Oporto, had been granted to Sir S. Morton Peto, Bart., with a subsidy of £5,500 per kilometre, timber from the Government forests on the line, a free grant of all Government lands over which it might pass, and of all mines and minerals within half a kilometre on each side of the line which had not been already conceded to other parties.

The land required for railway purposes might be purchased either by private agreement or by legal expropriation; but the latter process was generally found to be necessary, on account of the difficulty of ascertaining that all rights and interests in the property were extinguished. The paper then proceeded to describe minutely the expropriation system, which was not an expensive process, nor did it occupy much time. When the parties could not agree as to terms, arbitrators were appointed, but, should dissatisfaction still be felt, an appeal could be made to the superior courts in Lisbon. This system, although good in principle, and simple and expeditious in practice, was liable to great abuses; consequently the cost of the land for the Santarem Railway proved much greater than was expected, in some cases exorbitant prices having been demanded and obtained.

The Author then narrated the successive stages which resulted in the "Central Peninsular Railway of Portugal," to the first section of which, from Lisbon to Santarem, a distance of 45 miles, he was appointed engineer; not, however, until the contract had been determined between the Government and the Company. Upon examining the country, he found it necessary to make some material alterations in the line proposed, particularly at each end. For six miles out of Lisbon, as far as Sacarem, it was designed to be carried through a hilly country, with steep gradients and sharp curves. The site selected for the principal terminus at Lisbon was at the north side of the town, far from the river Tagus and the commercial part of the capital, which would have rendered necessary a branch line, nearly two miles in length, to the river, for the accommodation of the merchandise traffic connected with the port. Instead, the Author substituted a line with better gradients and curves, and lighter works, having a terminus adjoining the Tagus, within a short distance of the Custom-house. The Santarem end of the line was also entirely changed, for the purpose of removing it as much as possible out of the influence of the great floods to which the valley of the Tagus is subject, and also to facilitate the carrying forward the next section to the north.

The works were inaugurated on the 17th of May, 1853, and shortly afterwards a company was formed, the capital of which was £800,000, the contract for the entire execution of the works and for furnishing the rolling stock being taken by Messrs. Waring Brothers and Shaw.

This line was constructed along the northern side of the valley of the Tagus, skirting, and in places passing through the high grounds which bounded it, and which, in several localities, especially at Lisbon and Santarem, terminated in high cliffs on the river itself. The exact course of the line was then pointed out, and the nature and extent of the works described. After leaving Lisbon, it entered the high ground at Xabregas, successively arriving at the villages of Poço do Bispo, Olivaes, and Sacavem, at each of which there was a third-class station. From this place to the town of Villa Franca, a distance of $12\frac{1}{2}$ miles, the works were similar to those in the marshland districts of Lincolnshire and Cambridgeshire. Upon this portion of the line there were two third-class stations, to accommodate the villages of Povoa and Alverca, and a second-class station at Alhandra, where the railway crossed the famous lines of Torres Vedras, which here terminated on the Tagus. After leaving Villa Franca, where there was a first-class station, the line was carried upon a low embankment to the river Carregado, where there was another first-class station, for the accommodation of the traffic upon the new mail road, from this place to Coimbra. Thence it proceeded to the villages of Azambuja, Virtudes, and Ponte Sa. Anna, where there were second-class stations. It then skirted the foot of the hills to Ponte d'Asseca, where it crossed the river and valley, entering the high ground or promontory, on which stood the town of Santarem, the line terminating at a public road about one mile from that town. The total length of the line was nearly 45 miles. The gradients were for the most part good, upwards of 30 miles being practically level, and the steepest inclination being 1 in 111. The curves were also equally favourable, and the works were generally of an easy character. The earthworks averaged 45,535 cubic yards per mile, the cuttings being principally in a dry loam, intersected by thin beds of hard rock, composed of marine shells. The embankment along the margin of the Tagus at Lisbon, which consisted of soft, black mud, was formed of clay and rock from the cuttings, the latter affording an admirable protection to the outer slope, which by the action of the waves between high and low water gradually assumed a form resembling a natural beach. The fiscal engineer insisted that a heavy retaining wall of masonry should be constructed, but this demand was successfully resisted, and the result had justified the expectations of the Author. The embankment across the valley of the river Sacavem also caused some anxiety, owing to the weakness of the alluvial soil occupying the ravine, which originally formed the bed of the river; but after many thousand yards of dry sandy loam and rock had been deposited, and had been buried in the earth, it became thoroughly consolidated. The bridges were neither numerous nor large; the only ones considered worthy of notice in the paper being those over the public road from Lisbon to Poço do Bispo, at Xabregas, and over the river Sacavem. The former consisted of one skew opening (at an angle of 32° 30',) 22 ft. 4 in. in width on the square, and of three arches, each 22 ft. 6 in. span, and one 9 ft. span in the east abutment. The principal part of the work was executed in dressed ashlar masonry, with rubble backing, the arches being turned in brick, and the superstructure of the main opening being formed of cast-iron. The Sacavem bridge consisted of two side arches, each 25 ft. span, and of a centre opening 100 ft. span, crossed by two wrought-iron box girders, each 108 ft. in length, 8 ft. in depth and 2 ft. in width across the top and bottom plates; 35 transverse girders, each 25 ft. 6 in. in length, 15 in. in depth, and $6\frac{3}{4}$ in. across the top and bottom flanges, rested upon the bottom flanges of the large girders. The centre breaking weight of one main girder was 303 tons, and of the bridge, equally distributed, 1212 tons. The total weight of the iron work was 80 tons.

The permanent way was composed of a single-headed rail, weighing 60 lbs. to the yard, transverse timber sleepers, and ordinary cast-iron chairs, which were attached to the sleepers by compressed oak trenails. The ballast consisted, for the most part, of a coarse red grit, which set well, and being porous, formed a good road.

In conclusion, it was remarked that the partial opening of the line, for passenger traffic alone, to the Carregado station, about 23 miles from Lisbon, had completely disproved the assertion, that the peasantry in that country set no value on time; as it was found that they preferred that mode of travelling to the old and slow methods to which they had been accustomed—even though it was more expensive. The earnings had exceeded 15*l*. per week per mile, there being three trains each way daily.

It was announced that the following Paper would be read at the meeting of Tuesday next, the 16th inst.: "Statistics of the Railway System in Ireland, the Government Aid afforded, and the Nature and Results of County Guarantees," by Mr. George W. Hemans, M. Inst. C.E.

November 16.

Joseph Locke, Esq., M.P., President, in the Chair.

The Paper read was, On the Railway System in Ireland, the Government Aid afforded, and the Nature and Results of County Guarantees, by Mr. G. W. Hemans, M. Inst. C. E.

This communication was suggested by the address of Mr. Locke, M.P., President, in January last, which related chiefly to French railways. From that address it appeared that, in 1854, the French railway shareholder received, on an average, 9 per cent.; while, on the other hand, in 1857, the English railway shareholder only obtained 3·12 per cent., or less than what was derived from money invested in the Public Funds. In the one case, assistance and protection had been afforded by the Government; but in the latter, as was well known, speculation had been allowed to take its freest development. The result was that, at the end of 1856, in England and Wales alone, with an area of 58,000 square miles, there were 6,441 miles of railway opened; but in France, with an area of 204,000 square miles, there were only 4,060 miles of railway opened; so that England and Wales were relatively 500 per cent. better furnished with railways than France, and at the same time the accommodation on the individual lines was superior. It might be assumed, however, that although the shareholders lost by competing lines and duplicate stations, the country gained; for in no case had any line been actually closed for want of traffic, or because it was valueless.

Ireland, in 1836, was a blank, as far as regarded railways, as it possessed, at that time, only the line from Dublin to Kingstown, about 6 miles in length. An extract was then given, from an official document, to show the then depressed condition of the country, which resulted in the appointment, in 1836, of a Government Commission, consisting of Sir John Burgoyne, Mr. Barlow, and Mr. (now Sir) Richard Griffith, "to inquire into the manner in which railway communications could be most advantageously promoted in Ireland." During the labours of this Commission, many Joint Stock Companies were held in abeyance. The Report was finally made in July, 1838, its main recommendations being considered sound and good. It advised the construction of great leading communications, each in possession of an important district, and strongly insisted on the vital importance of protecting them from the ruinous rivalry of competing lines. The lines actually made, however, especially in the Northern part of the country, were widely different from those suggested by the Commissioners, and the railway interest had suffered accordingly. There were already two trunk lines to the North, instead of one, and a third line was in contemplation. Two main lines also existed to the West, and three to the south, from Dublin. It was imagined by the Commissioners that the lines might be made for £11,000 per mile on an average; that the receipts would amount to £17 15s. per mile per week, on the supposition that the exports amounted to 700,000 tons; that the cost of locomotive power would be 2s. 3d. per mile, at a speed of 30 miles an hour; that the utmost profits would not exceed $3\frac{1}{2}$ to 4 per cent.; that the Western line could not be attempted without ruin to the shareholders—it had since been made, and was paying a dividend of 5 per cent.;—and that the line from Newry to Dundalk was physically impossible.

Although these mistakes had been made, arising from want of experience, the final recommendations of the commission were excellent. A uniform guage was insisted on, although the exact dimensions recommended by them were not ultimately adopted; and Government was advised to advance two-thirds, or even the whole, of the capital for the construction of the leading lines, the principal and interest of such advances to be secured on local, or baronial rates, in such districts as should consent so to obtain the benefit of railways. This principle had already been adopted, in Ireland, for the Shannon navigation. The report was laid before Government, but as no steps were taken to carry out its recommendations, great discouragement was given to the financial success of such undertakings by private companies. In this way, speculation languished for nearly six years, only two lines—the Ulster and the Dublin and Drogheda—being slowly made. When, however, the railway mania attained its height in England, it extended to Ireland, and then the country began to make for itself, and with little regard for anything like a national system, the various lines now in existence, almost all of which were originated in 1845 and 1846. But the panic arose, and subsequently the famine of 1847, which stopped enterprise for a time; and although, as an alleviating measure, the Government were strongly urged to assist Irish railways, at which period only 123 miles had been opened, the acts having been passed for 1,500 miles; yet the proposition was rejected, and instead, the people were fed without giving any labour in return, or were employed in the mockery of useless road-making. About eight millions sterling were so expended, none of which, although originally intended as a loan, had, the author believed, ever been returned to the imperial treasury. Subsequently aid was given to the railways to a considerable extent, in another form. More than two millions sterling were lent to Irish Companies, who had obtained Acts of Parliament, through

the agency of the Public Works Loan Commission; and although the rate of interest, in most cases 5 per cent., was, in the author's opinion, too high, the railway system had been materially assisted and promoted, and not one bad debt had been incurred. Only one line had been executed on the principle recommended by the commissioners in 1838, that of charging a low rate of interest, secured on the guarantee of a local rate, in aid of the profits of the line, with an additional rate, commencing ten years after the opening of the line, and payable by the company, as a sinking fund, to replace the whole amount of the loan. This exception was in favour of the Midland Great Western of Ireland, to whom a loan of five hundred thousand pounds had been granted to construct the line between Athlone and Galway. The interest was at the rate of $3\frac{1}{2}$ per cent., and the sinking-fund rate $1\frac{1}{2}$ per cent. additional. In this case, the representatives of the counties of Roscommon and Galway voluntarily consented to a compulsory rate, guaranteeing to make up the difference between the profits of the line and the interest, provided the Company were compelled to construct it with the borrowed money, and to pay out of their own funds the additional $1\frac{1}{2}$ per cent. as a sinking fund. The time in which the whole sum would be repaid was about thirty-five years. The author having previously constructed the line from Dublin to Mullingar, was appointed to execute the extension to Athlone and Galway, the whole length of which, $76\frac{1}{2}$ miles in extent, was opened simultaneously in August, 1851, within twenty-two months from the commencement of the works. In the first half-year the deficiency of profit was only 1·4 per cent., and afterwards 1·6 per cent., instead of the whole $3\frac{1}{2}$ per cent.; and in every succeeding half-year the profits had increased, until they are now fully equal to the interest payable to Government. The total sums paid by compulsory rates on the county of Galway, and the two baronies of Roscommon, had amounted to £37,414. The author thought it would be conceded, that the guarantee system had in this instance proved highly beneficial; and as a further proof that this was felt to be the case, he mentioned, that since the completion of the Galway line, many attempts had been made to obtain similar guarantees for other lines, but when the Bills came before Parliament, the most determined official opposition was given to the guarantee clauses, so that only three had passed—the Killarney Junction, the Bandon and Bantry, and the Bagnalstown and Wexford,—and in these, the clauses were so hampered with impossible and useless conditions, and so emasculated, that they were found to be totally inoperative. Hence the original recommendation of the Railway Commission, that lines should be guaranteed by local rates, which had been successful in the only case attempted, had not been acted upon. The system had been found to work well in France and in other Continental States, as in India and other colonies—and was frequently compelled to be adopted in the case of gas, water, roads, drainage, &c., yet it was held to be inapplicable to railways.

At the end of 1856 there had been constructed in Ireland 1,056 miles of railway, rather more than one-half of which were single line, though the works were for double way. The cost had amounted to fourteen millions, the average per mile having been less than £15,000; but lately this had been reduced to from £6,000 to £7,000 per mile. The average receipts were £21 per mile per week; the dividend amounted to $4\frac{1}{4}$ per cent. nearly, and the working expenses to 39 per cent. In England these figures were—receipts, £60 per mile per week; dividend, 3·56; and working expenses 49 per cent. respectively; the cost per mile having reached £40,000. The favourable result here indicated was attributed to economy in construction and in working.

REVIEWS.

A Manual of Applied Mechanics. By William John Macquorn Rankine, LL.D., C.E., F.R.SS.L. & E., &c.; President of the Institution of Engineers in Scotland, and Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. Richard Griffin and Co., London and Glasgow. [Fourth Notice.]

Having disposed of the important questions, "What is the object aimed at by the Author, that is, for what purpose has the book been written?"—in what manner have the objects aimed at been realised with respect to the quality and quantity of material used, and also its arrangement?" it now remains to devote a few lines to the response which the "Applied Mechanics" can give to the third question,—

3. "Is the logic of his definitions, the force of his demonstrations, clear and convincing, either to the practical man, or to the man of pure science?"

Before, however, we proceed to the consideration of the answer to this question, it may not be entirely void of interest to return for a few moments to the "Preliminary Dissertation." Here we are taught, in the most absolute manner, as if Mr. Rankine combined the genius of Newton and Stephenson, that "mechanical knowledge may obviously be distinguished into three kinds: purely scientific knowledge, purely practical knowledge, and that intermediate knowledge which relates to the application of scientific principles to practical purposes, and which arises from understanding the harmony of theory and practice." We are further told that the first part consists in producing in the student an improved understanding, and, if possible, qualifying him to become an original thinker and an eminent scientific discoverer; the second is that knowledge which a student acquires by his own experience and observation; and the third consists of the union of the first two; for the promotion of which the Professorship of Applied Mechanics was established in Glasgow University. Mr. Rankine never gave utterance to a greater truth, and one which always did and ever will elevate itself in a hostile position to collegiate training, when he stated that "instruction in purely practical knowledge is that which the student acquires by his own experience and observation of the transactions of business." The great object of this professorial chair is, we are told, to qualify the hopeful student of engineering science "to plan a structure or a machine for a given purpose, *without the necessity of copying some existing example*, and to adapt his designs to situations to which no existing example affords a parallel. What a wonderful chair of philosophy this is at Glasgow University! And what a wonderful person he is who occupies it, when by the waving of his magical wand he can transmute the dullest dolt into the most original, efficient, and commanding engineer! If the public had confidence in the powers of Mr. Rankine to accomplish such surprising feats of intellectual induction as those shadowed forth in his "Preliminary Dissertation," then we would venture to predict that Glasgow University would be more distinguished and more sought after than any University in Christendom. Is not Mr. Rankine aiming too high? Is he not too visionary in his speculations? And does he not exhibit the qualities of an aspiring ambition for intellectual greatness, rather than the experience of a sober teacher, when he professes to teach his students to be original and to *despise* the *experience* of their *fathers*? Mr. Rankine would, we feel certain, render greater service to the promotion of the application of pure science to practical purposes, by the appreciation of a more humble and correct view of his own capabilities of teaching, within the walls of his college, those subjects which all practical and sensible men believe can only be acquired by experience and observation, in the discharge of the actual duties of life.

In reading over the "Applied Mechanics," we have been so struck with the illogical statement of many of the definitions, the inelegant and obscure and frequently inaccurate demonstrations, that we cannot, in justice to our readers, omit noticing a few of them. For instance, "matter" is that which fills space. We have been taught by the most original thinkers, and the best and experienced teachers, to regard it from a very different stand-point. Everything is matter, says Dr. Whewell, which possesses the power to resist the action of force. Query, is there nothing besides matter which fills space? Then, again, *rest* is defined by Mr. Rankine to be "the relation between two points, when the straight line joining them does not change in length nor in direction." We are ready to admit that the definitions of *rest* and *motion* have perplexed metaphysical philosophers from the earliest period of Grecian civilization to the present time. And really Mr. Rankine has not made great progress in consolidating the conflicting views of preceding thinkers on this difficult inquiry, which is, after all, very plain and obvious to every untutored peasant in the highlands of Scotland. It may, with great justice, be asked, in reference to Mr. Rankine's definition—Is it not possible for two bodies or material points to move with equal speeds, as great as the comet of 1858, and still comply with his definition? Suppose them, for instance, to move in parallel directions, then the line joining them does not alter in length or direction. *Force* is stated to be the action between two bodies; and its nature is determined or made known "when the following three things are known respecting it:—First, the *place*, or part of the body to which it is applied; secondly, the *direction* of its action; thirdly, its *magnitude*." We have been often surprised to observe the obtuseness of Mr. Rankine in perceiving the consequences of his definitions. What, in the name of common sense, has the knowledge of the three things to which he refers to do with the nature of a force? It is true that a knowledge of the three things here alluded to is absolutely necessary to determine the motions of a given mass to which the *force* is applied; but we cannot conceive what they have to do with the nature of a *force*. We have been taught to regard *force* as being that which produces, or tends to produce, motion in a body. And, notwithstanding the aptitude exhibited by our Author for change and originality, we shall not be easily persuaded to relinquish the notions of these subjects which we have learnt from respectable Cambridge writers.

Lest the examination of other definitions should weary, we shall now proceed to a different field of labour. At page 21 commences one of the most singular chapters on the theory of Couples which we ever remember to have seen. Whether we regard the notation, the arrangement, or the logic of the proofs submitted for our instruction, the conclusion is inevitable, that a more wretched attempt at original display does not exist in the annals of science, since the well-known Hoëne de Wronski announced a general method of solving all algebraical equations, than the application of the doctrine of couples to the demonstration of the properties of parallel forces and the parallelogram of forces. Let any competent person compare this chapter on couples with the third chapter in Mr. Todhunter's "Analytical Statics," and we shall be surprised if he do not condemn the whole of Mr. Rankine's performance as being irregular, unsound in principle, and wanting also in that clearness and brevity which ought to be a chief characteristic of a book on Applied Mechanics. The usual definition of the axis of a couple is departed from, and a very questionable one substituted in its place. The *axis* of a couple is "a line perpendicular to the plane of the couple, and proportional in length to the moment of the couple; and not, as stated by Mr. Rankine, "a line perpendicular to the plane of the couple" simply. How does Mr. Rankine reconcile his definition of a couple with Section 2, page 24? It appears to us that Mr. Rankine has committed the vital error of confounding the arithmetical equivalent of couples with their power to turn a body about an axis. Are we then to accept the proof of "two couples of equal force acting in the same direction, with the same axis, are equivalent to a couple whose moment is the sum of their moments," simply on the ground of their moments being equal? Mr. Rankine's method of proving this proposition is as follows:—Let (a) and (b) be the arms of two couples whose force is F, and whose moments are a F and b F respectively. Then, because $a\,F + b\,F = (a + b)\,F$, geometrically, Mr. Rankine infers that the two couples on the left-hand side of this equation are as effective in turning a body about an axis as the couple on the right-hand. This, we conceive, is not very profound reasoning for a man of Mr. Rankine's mathematical pretensions. Again, the mode of proof employed in the proposition of "the moments of two couples acting in the same direction, and with the same axis, are equal, those couples are equivalent," is equally unsatisfactory. The following supposition is made with respect to the couples whose moments are a F and a' F'.

$$\frac{a}{a'} = \frac{F'}{F} = \frac{n}{m} \quad (m \text{ and } n \text{ being whole numbers}).$$

From this equation he justly infers that

$$= \frac{F}{m} = \frac{F}{n}$$

$$l = \frac{a}{n} = \frac{a'}{m}.$$

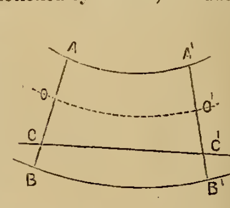
And then concludes—very illogically, as we conceive—that the coupl e whose moment is a F is equivalent to (mn) couples whose moment is lf. This inference is correct enough, geometrically considered; but this is not the point in question. It has no more to do with the real difficulty of the argument than the statement of two learned professors occupying similar chairs in distinct universities has to do with the profound proposition—are their intellectual powers and suavity of manners equal in both cases? The only effect of the supposition is to divide the original couples into (nm) couples; and, therefore, the same mistake is made upon each of these couples as was made upon the couples a F and a'F'. Let any one compare the demonstration of the equilibrium of three parallel forces, given in page 26, by means of couples, with the usual methods of proof adopted by standard authors of great merit, and we will predict that an inference will be made by no means favourable to Mr. Rankine's high reputation as an accurate logical elementary writer. We shall now make a passing observation upon Mr. Rankine's proof of the parallelogram of forces. A proof of this important problem, conducted entirely upon statial principles, has been justly considered a desideratum in mechanical science. There are two modes of proving this problem, which have been more favourably regarded by mathematicians than others. The first is known as Duchayla's method, which is adopted by Professor Moseley, Todhunter, and Goodwin; the second depends upon the property of the lever, and is given by Dr. Whewell, Snowball, and other celebrated writers. We shall not attempt to decide which of these two modes of proof is the best, and the least objectionable, on the grounds of the suppositions which are found to be necessary to complete the steps of the demonstration. Each method has its admirers, and each has its logical defects. The simplest and least objectionable proof of this proposition is given by Mr. Woolhouse, in the *Ladies' Diary* for 1838, page 44. To these demonstrations Mr. Rankine has added another, which he has given at page 35 of his book on "Applied Mechanics." The method of proof depends upon the theory of couples, and is made to hinge upon the statement that the *resultant of two forces must be a force such, that its moment, relatively to any axis whatsoever, perpendicular to the plane in which the forces act, is the sum of the moments of the two forces relatively to the same axis.*

As the principal properties of couples are established by Mr. Rankine in a very loose and objectionable manner, and as he applies these properties to the proof of the parallelogram of forces, the same unsatisfactory steps in the process of reasoning which prevail in one case may be expected to prevail in the other. Although the resultant thus determined of two forces produces a moment about an axis equal to the sum of the moments of the same two forces, is it logical to infer that the resultant is equal to the sum of the forces? It is important in writing on elementary subjects to preserve, as much as possible, the same definitions which are adopted by eminent and standard authors; and where it is necessary to depart from the usual course, such a proceeding should be particularly stated, and reasons given for such a departure. In page 49, it is stated that the "specific gravity of a body is the intensity of its weight, or the weight of a unit of its volume." In turning over the pages of Dr. Whewell to refresh our memories, we find him stating the specific gravity of a body to be "the proportion of the weight of any magnitude of a certain standard substance" (pure water). Thus, if s is the specific gravity, and W the weight of a substance, whose volume is V cubic feet,—

$$s = \frac{W}{V}, \text{ according to Mr. Rankine.}$$

$$s = \frac{W}{62\frac{1}{2}\ V}, \text{ according to Dr. Whewell.}$$

Why should Mr. Rankine make this discordance without stating the grounds of it, and without drawing the attention of his readers especially to it? In introducing the ordinary law of friction—that is, in stating that friction is proportional to the pressure between two surfaces—Mr. Rankine, in obedience to his desire for change, without a corresponding advantage, calls it the "law of solid friction." These trifling innovations, of no importance in themselves, are so many defects in the "Applied Mechanics," and indicate an undue pressing after originality and some unattainable object. Really, there seems to be no necessity whatever for the introduction of such a term as "solid friction," except to show that Mr. Rankine, at all hazards, will be original, and not satisfied with the usual modes of expression sanctioned by custom, and adopted by authors of great reputation. It would confer a great and lasting benefit on the practical as well as the theoretical man if Mr. Rankine would devote his abilities for originality to the removal of some of the obvious difficulties which surround the mathematical theory of the strength of materials. In page 322 there is an investigation respecting the "*proof deflection of beams,*" in which it is stated that if (a) represent the proportional elongation of $c\ c'$ (in the annexed Figure), whose distance from the neutral surface, $o\ o'$, is (y), and (r) the radius of curvature of the neutral surface, we must have



$$1 : 1 + a :: r : r + y;$$

and, consequently, the radius of curvature is

$$r = \frac{y}{a}.$$

The reasons for such a step in the mathematical theory of the strength of materials are not even alluded to by Mr. Rankine; and whether it is an absolute geometrical necessity imposed upon the magnitudes a, r, and y, or whether it is dependent upon accurate experimental data, does not appear from the investigation. It is true that when the concave side, A A', of the bent beam is compressed a given quantity, then the convex side, B B', becomes determinate, and cannot, except by an appeal to experiment, be such that the lines B A and B' A' are both perpendicular to the neutral surface, $o\ o'$—a result absolutely necessary to the proportion $1 : 1 + a :: r : r + y$.

If we turn to the problem in page 332, "Beams Fixed at both Ends," we find the same absence of mathematical correctness of which we have had many times to complain in reading the pages of "Applied Mechanics."

Mr. Rankine's solution to this important question is as follows:—"Compute the slope i which the neutral surface of the beam would have at the points of supports if it were simply supported there, and not fixed. Then, find the *uniform* moment of flexure, which, if it acted on the beam in such a manner as to make it become convex upwards, would produce a slope at the points of supports, *equal and contrary* to i." It is difficult to comprehend the meaning in this solution of a *uniform moment*. Mr. Rankine's peculiar and original notions on stress should have conducted him to a very different solution to the one which he has here given. Are we to understand that a moment (which, when applied to the beam, will produce a neutral surface such that a tangent to it at the point of support is parallel to the horizon), is exactly the moment which would be produced by the ends of the beam becoming fixed or embedded in masonry? We think not. And any solution to this question which does not recognise the length of the beam embedded in the masonry is, in our opinion, defective. The whole of Mr. Rankine's performance on the strength of materials is much mystified by the introduction of certain factors into the formulæ. This procedure may give to his investigations an air of generality; but we are compelled to confess, it is at the expense of clearness and definitiveness which should be a prominent feature in a "Manual" on science. We are particularly informed in page 361 of the eminent services of a Mr. Lewis Gordon in the determination of the strength of pillars. All this gentleman has done is, it appears, the substitution in a forgotten formula from Tredgold, of the elements of strength of pillars from Professor Hodgkinson's experiments. For the accomplishment of this schoolboy's task in the commencement of his Algebraical studies, Mr. Lewis Gordon has been placed on a pedestal by no means becoming his real position. Mr. Rankine's honesty of purpose and impartiality of conduct are seriously imperilled by the statement, "that the laws which govern the strength of cast-iron pillars, discovered by the experimental researches of Professor Hodgkinson, are empirical. Are not the laws dependent entirely upon experiment, in connection with the strength of pillars, as fixed as the laws which regulate the motion of a planet or comet? That the strength of cast-iron pillars of equal length and diameter, when both ends are flat, when one end is flat and the other rounded, when both ends are rounded, is proportional to 1, 2, and 3, is a physical truth which will be read with great interest, long after the "Applied Mechanics" is resting on the dusty shelves of some learned library.

We can only spare time to refer to another subject, in which the author has exhibited a great degree of ignorance;—we refer to the subject of the stability of ships, as given in pages 600 to 604. In order to make ourselves understood, and also to point out Mr. Rankine's inaccuracies, it will be necessary to describe the conditions of equilibrium of a floating body. These conditions are, when a ship floats in a state of stable equilibrium, first, the weight of water displaced is equal to the weight of the ship; secondly, the line joining the centre of gravity (G) of the ship, and the centre of buoyancy (H), is perpendicular to the horizon. These are the only conditions necessary for equilibrium. Now, if the ship is, by some cause, inclined through an angle (O), the centre of buoyancy will describe a curve, and its position corresponding to the inclination is H'. Draw the line H' M perpendicular to the horizon, to meet the line G H produced in M; then Mr. Rankine states, truly enough, that the moment of the ship to right itself is proportional to G C, perpendicular to H' M; but he is far from right in stating that M, thus determined, is the metacentre. The metacentre is a very different point, which we will endeavour to explain. Now, the line H' M is evidently a normal to the curve, H H', at the point H', and, therefore, the centre of the circle of curvature is on this line. The successive centres of the circle of curvature to the curve of buoyancy, as the ship is inclined through an angle, describe a curve, and the point where this curve meets the line, H G, produced, if necessary, is the metacentre.

No purpose would be gained in following Mr. Rankine through the successive steps of his approximate formulæ to determine the stability of ships, as they have no application in practice.

Mr. Rankine's definition of the *dynamical stability of ships* is "in her righting herself rapidly." We wonder Professor Moseley can be silent with such an exposition of his views on the dynamical stability of ships as that given in the "Manual of Applied Mechanics." A certain number of units of work is necessary to be done in heeling a ship through an angle O; and the *dynamical stability of a ship* is proportional to this work, according to the views of Professor Moseley, or we have read his investigations with as little profit as Mr. Rankine. The above are only a few of the defects which have presented themselves to our notice, and we must state that such defects are incompatible with the utility of such a work by so distinguished an author.

Recent Practice in the Locomotive Engine (being a supplement to "Railway Machinery"); comprising the latest Improvements, and a Treatise on the Locomotive Engines of the United States; illustrated by a series of Plates and numerous Engravings on Wood. By Daniel Kinnear Clark, C.E., London, and Zerah Colburn, C.E., New York. Blackie and Son. Parts 1, 2, 3.

Mr. D. K. Clark, the author of the present work, fortunately possesses a world-wide reputation as an authority upon railway engineering matters, which

renders it scarcely necessary to do more than announce the commencement of a new series of, or supplementary numbers to, the already well-known and highly valuable standard work on "Railway Machinery," which he completed about three years ago.

Mr. Clark, besides possessing the advantage of a facile pen and ability to convey succinctly the information which he, during considerable practical experience, has acquired, upon subjects treated by him in his published works, has also the great merit of combining, in an eminent degree, accurate observation with analytical ability.

This work, as mentioned in the title, is supplementary to the original work on "Railway Machinery," by Mr. Clark, the publication of which was completed upwards of three years since; and though the locomotive engine, in various respects, has made but slow advances during the interval, yet it has undergone, and now undergoes, material modification in respect of the boiler—constructionally, as well as in working. The strength of a boiler is a question of increasing importance, as working pressures are augmented, and quality of material and mode of construction must necessarily be studied. Fuel is costly, and coal must be substituted for coke; and the boiler has to be adapted for the economical and efficient combustion of coal. In the department of locomotive practice, great advances have been made of late, and much useful experience has been gained. In respect of English practice, then, it would appear that the work before us may be accepted mainly as a treatise on the English locomotive-boiler, embracing, in the first place, the strength of the materials used in its construction, of riveted and welded joints, and of stayed-surfaces, with general principles, rules, and data affecting the construction of the boiler, amply supported by practical evidence. In the second place, the phenomena of fuel and combustion promise to occupy an important place in the English section; and we should say that, in the present transitionary state of railway practice in fuel, this department must prove of essential interest and importance to the railway world.

In the discussion of boiler-plate joints, Mr. Clark demonstrates that the bursting strain on the longitudinal seams of cylindrical boilers is double the strain on the circular seams. This is an important practical distinction, because it is clear that, to ensure uniform working strength, the longitudinal seams must be doubly fortified; and, in the consideration of the means of soldering, four distinct kinds of riveted joints are compared, and their relative strengths determined from actual trials. Welded joints are likewise discussed, and should the reported results of their capabilities to resist bursting strains be corroborated by advanced experience, they promise to supersede riveting, if not entirely, at all events, for the principal joints. In the order of tensile strength the joints are ranged thus:—

"1. Scarf-welded joints	100	
2. Double-riveted double-welt joint	80	per cent
3. Double-riveted lap-joint	72	,,
4. Lap-welded joint	66	,,
5. Double-riveted single-welt joint	65	,,
6. Single-riveted lap-joint	60	,,

In this comparative statement the strength of the entire plate is represented by 100; and the trials were made with plates varying from ⅜ inch to ½ inch in thickness. The relative strengths of single and double-riveted joints do not very materially differ from those deduced by Mr. Fairbairn.

Still greater is the necessity for fortifying the longitudinal seams of the boiler, inasmuch as the furrowing of boiler-plates—a subject which has usually been treated mysteriously—has been observed to arise near to and parallel to those seams. But, in this matter, we cannot do better than leave Mr. Clark to speak for himself, commending the following extract to the careful perusal of our readers:—

"*Furrowing of Boilers at the Joints.*—Probably the most important practical inference to be drawn from the tests of the strength of riveted joints, is the explanation they supply of the failure, hitherto unexplained, of boiler-plates, not at the joints, but in their neighbourhood. We are aware that electrical and galvanic action are freely adduced in explanation. But these words have two meanings:—they mean electricity and galvanism; and they mean ignorance and mystery. It is known that boilers fail by corrosive and other agencies eating into the plates, on the inside, pitting and furrowing the surface. The pitting of the metal is readily explained by the presence of chemical agents in solution in the water, and the known inequality of substance of iron plates and bars, in consequence of which the metal is gradually but unequally separated and dissolved; and probably a weak galvanic circuit may be established between the iron shell and the brass tubes, accelerating the process of dissolution. But this explanation does not meet the frequent case of a straight continuous furrow, cut like a groove upon the surface. Furrows are observed to be formed parallel to, and close to the riveted joints. Not in any case, that we are aware of, have they been found at any notable distance from a riveted joint, nor otherwise than parallel to one. The inference is inevitable, that there is a relationship betwixt them: and our conviction is, that the alternate tension and relaxation of the plates at the joints, as the steam is got up and let down, are attended by an alternate distortion, incipient it may be, and resumption of the normal form, a bending and unbending of the plates on each side of the joint; in consequence of which the texture of the metal is gradually loosened, in lines near to, and parallel to the joint, and it is thus laid open to corrosive action. On this interpretation, the commencement of a groove or furrow, establishing a weak place, and concentrating the action there, would suffice to extend and deepen it, to the dangerous limits occasionally announced by explosions.

"The weakness attendant on lap-joints is strikingly exemplified in the lap-welded joint, when subjected to extreme tension; the tensile strength, though the metal at the weld is perfectly solid and fully as strong in itself as the body of the plate, is much below that due to the regular section of the plate. Here, there is no elementary weakness in the reduction of metal by rivet-holes; the inferiority of strength arises solely from the bending of the plates on both sides of the lap, and the overstraining of the fire-box, in the endeavour to attain to the position of stability.

"Mr. John Sewell, commenting on the corrosion of locomotive boilers, ascribes the furrowing of plates at rivet-joints to the interruption of the vibrations of the boiler by these joints, the localization of the fatigue at these places, and the increased susceptibility, in consequence, to corrosive action.* This action has, doubtless, a tendency to aggravate the evil of lap-jointing; but we are disposed to ascribe the evil to the lateral bending and unbending of the plates as the primary cause.

"The furrowing of lap-jointed plates reads an important lesson on the real and intimately practical value of direct connection and direct action, in exerting, transmitting, or resisting forces.

"That the furrowing of plates at the riveted joints results from the indirectness of the strain of the steam pressure is rendered still more probable by the analogous furrowing which results from reciprocating strains of another kind. In the more ancient classes of engines, in which the cylinders are fixed to and work from the smoke-box plates, the alternate forward and backward strains by the steam pressure on the piston have been observed to weaken and to subject to corrosion and leakage the substance of the plate along the edge of the angle iron at the junction with the barrel. In further corroboration of this doctrine, Mr. Colburn states that he is not aware that any accidents from furrowing of boiler-plates have taken place in the United States; and we believe that their immunity from accidents arising from this source, is to be ascribed to the use of very thin boiler plates, 1-4th to 5-16th inch thick."

We cannot dismiss the subject of riveted joints without alluding to one other remarkable conclusion from the experimental results,—that a ⅜ inch plate, having a single-riveted lap-joint, is absolutely stronger than a ½ inch plate with the same kind of joint.

The question of stayed flat surfaces of boilers is treated in the same exhaustive style. Mr. Clark accords the preference to copper stay-bolts over those of iron, on account of their superior pliability to lateral strains, arising from the unequal expansion of the frictive and its shell. On this subject, Mr. Clark says:—

"It is not a question of strength, for copper is abundantly strong enough, though iron is ultimately stronger; but, unless it is wished to prove a boiler to a bursting pressure, the superior strength of iron is not of any direct practical value, in existing practice, as a stay-bolt. The question is one, not of strength, but of durability; and the drift of evidence appears generally in favour of copper bolts—iron bolts proving, in general, more susceptible of corrosion, and more liable to snap. Individual makers place iron stay-bolts in the uppermost two or three rows; and the remainder of copper, as lying more within the latitude of corrosive influences. Too great stress has been laid on the superiority of the strength of iron over copper, as a material for stay-bolts; and where cheapness tells in favour of a substitution, as of iron for copper, the mechanical inducements to make the change should be decided. They are not so in the present condition of the question, and therefore, in our judgment, copper should be preferred for the material of stay-bolts. Another question supervenes, of much greater import, as to the quality of the water used in locomotive-boilers, for that is, no doubt, one cause of corrosion; to this question we shall return at another time.

"It is obvious that, in the way boilers are constructed, the entire pressure on the roof of the fire-box, or, strictly, upon the horizontal area of the base of the fire-box, must be resisted by the stay-bolts and the mediums of junction at the base; and it is not impossible that the downward pressure considerably strains these lateral overhung supports; besides, the rates of expansion of iron and copper under varieties of temperature are different. A locomotive boiler is observed to expand 3-16th inch in a length of 15 ft., or, say 1 in 1,000, in rising from an ordinary temperature of 62° to 365°—the temperature of steam of 150 lbs. pressure per inch. Again, according to ordinary unauthenticated tables, copper expands by heat half as much again as iron, and, taking the mean temperature of the copper of the fire-box at twice as much as that of the shell,—an assumption which, we suppose, is something much below the fact,—the vertical expansion of the fire-box would be, upon the whole, three times as much as that of the shell, and the difference of expansion would be twice that of the iron, or at the rate of 1 in 500. On a fire-box 5 ft. 3 in. high, the difference of expansion would, at this rate, amount to 1-8th inch. That is to say, the upper stay-bolts would be deflected 1-8th inch from their normal position when under the power of high-pressed steam. On a length of 3 in., a deflection of 1-8th inch is immoderate; and, considering the alternate expansion and contraction, bending and relaxing, attendant upon getting up steam and letting it down, it is reasonable to conclude that the same cause of degradation is at work with the stay-bolts as that already suggested for boiler-plate at the rivet joints,—the alternation of strain, tension, and relaxation, which loosens the texture, and ultimately overpowers the cohesion of the material so treated,—incurring partial fracture and accelerated corrosion. On this argument, the failure of stay-bolts should, as in fact it is, be localized at or near their junctions with the plates, which are the points of maximum strain, similarly to the localization of furrows near rivet joints. Occasionally, entire rows of rivets are found to have snapped across, close to the plate, independently of corrosive action; suggesting a cause of failure precisely the same as that which breaks axles,—an alternating lateral strain and relaxation, beyond the limits of enduring elasticity."

* "As riveted joints destroy the elastic homogeneousness of the boiler, the waves of expansion, contraction, and vibration, are arrested there by the greater rigidity of the riveted double thickness of metal, which tends to localize the fatigue sustained by the iron near these points, and it also appears to increase the susceptibility to corrosive action, since the furrows generally take the line of that fatigue, and are often deeper than the spots on the plates.—*Report of the Board of Trade on Railway Accidents*, 1855, page 49."

The treatment of the subject of fuel and combustion is opened in the third part, now before us, in which the chemistry and the physical conditions of the complete combustion of coal, in their practical applications to the locomotive-boiler, are investigated at length. Mr. Clark promises a historical notice, in the succeeding numbers, of the various designs and expedients for the prevention of coal-smoke in locomotive-boilers, that have been tried or practised in England. The most important problem, he considers, with which engineers have to deal, is, not the production of a new and distinct type of boiler for the perfect combustion of coal, but the production of a cheap, simple, effective method of ensuring the complete, smokeless combustion of coal, conveniently and readily applicable to locomotive-boilers as they now are. When the publication of this part of the work has farther advanced, we purpose to return to it at greater length.

The illustrative plates and wood-cuts of recent English and American locomotives are prepared with the usual lucidity and attention to detail, which characterise the illustrations of the former publication on Railway Machinery.

LIST OF NEW BOOKS AND NEW EDITIONS OF BOOKS.

BURNELL (G. R.)—The Rudiments of Hydraulic Engineering. Part I., 12mo., with illustrations, 1s. 6d. (Weale.)

COLBURN (Z.) and HOLLY (A. L.)—The Permanent Way, and Coal Burning Locomotive Boilers of European Railways. Cloth, 42s. (Hebert, Cheapside,)

OGILVIE (G.)—The Master Builder's Plan; or, the Principles of Organic Architecture as indicated in the Typical Forms of Animals. 6s. 6d. (Longman.)

EARNSHAW (S.)—A Treatise on Statics: containing examples illustrative of the General Principles of the Science. 10s. (Bell.)

TOMLINSON (C.)—Illustrations of Useful Arts and Manufactures. 4s. (Christian Knowledge Society.)

FRENCH (B. F.)—History of the Rise and Progress of the Iron Trade in the United States from 1621 to 1857; and other information relating to Statistics of Manufacture, Importation, Exportation, and Prices of Iron for more than a Century. 10s. (Sampson Low.)

BUCKLAND (F. T.)—Geology and Mineralogy, considered with reference to Natural Theology. 24s. (Routledge.)

HASWELL (C. H.)—Mensuration and Practical Geometry; to which is appended, a Treatise on the Carpenter's Slide Rule, and Guaging. 5s. (Sampson Low.)

SILLOWAY (T. W.)—Text-book of modern Carpentry, on Building timber, with Rules and Tables for calculating its strains to which each timber of a structure is subjected; and Observations on Roofs, Trusses, Bridges, &c., illustrated. 7s. 6d. (Sampson Low.)

NOTICES TO CORRESPONDENTS.

R. C.; I. P. Y.; 3rd Class Engineer; P. (*Naval Club*); J. Newhall; and A. How.—We regret that we cannot find space for your communications upon the subjects of "Steam Propulsion," "The Power required to Propel Ships at various Speeds," and under other titles, letters relating to the subject which has been so long discussed in THE ARTIZAN. The letter signed P. Unch, C.E., dated November 20th, from its amusing character, is made an exception; but as we cannot give it place under the head of "Correspondence," and as the writer alluded to in the squib does not object to its publication, we give it herewith:—

"STEAM-SHIP CAPABILITY.

"*To the Editor of* THE ARTIZAN.

"SIR,—Have any of your readers been reminded during the progress of this amusing, if not instructive, controversy, of the mechanical toy called Gyroscope? This toy, instead of obeying the downward solicitations of gravity, gyrates round and round, all the while *spinning* and humming in a most lively manner. Our argumentative Gyroscope (known by his initials) is strangely *square*, whilst the toy is round; but he aims at *revolution*. He *spins* (no end of argument) and hums in a most lively fashion; and he resists the downward pressure of an overwhelming weight of truth. He gyrates round and round the point, but the downward pressure is ever upon him, and, like the toy, the moment the gyration ceases, or is prevented, down he must go. "P. UNCH, C.E.

"P.S.—Our *square* friend's fallacy also resembles a lady's crinoline: when you try to press it in on one side, out it flies somewhere else,"

J. Johnson; C. Robertson; I. Lethew; and others—Your inquiries, received late in the month, will be replied to through the post.

C. O'Reigan.—Such an association has been in existence for a considerable time in Manchester, and is found to work well. The Steam Boiler Assurance Company has also been projected more recently. Forward your address, and we will endeavour to obtain the particulars you require, and send them to you.

J. Lawrence.—Coombe's expanding pulleys will answer your purpose. The address is J. Coombe and Co., Belfast.

S. Séquin (Marseilles),—Apply to R. S. Newcall and Co., Gateshead; or to Messrs. Glass, Elliott, and Co., East Greenwich.

Z. E. O. (Lisbon).—Send your correct name and address, and we will forward you the particulars. A French engineer, who is about to leave for Lisbon, will no doubt oblige us by taking charge of the documents and papers required, and will deliver them to you.

Y. (Carthagena, Spain),—First, 90 lbs. per yard; second, 4 ft. 8½ in. gauge; third, 35 miles per hour; fourth, T. Wright and Co.'s transverse double sleeper and joint chair, and intermediate flat cast-iron sleepers, with 70 lbs. rails at £7 per ton, and the cast iron at £5 per ton, would make the cost stand thus: 176 tons of cast iron, £880; rails, 110 tons, £770; bolts. 4 tons (at £18), £72; in total, £1,772 per mile. The rails estimated are the 70-lbs. single-headed flat-bottomed rail. Fifth, the patent of B. Parker is for a permanent way constructed entirely of iron, a permanently elastic material being introduced between the chair and the sleeper. If the material of these bed pieces is really permanent in its character, and will remain uninfluenced by moisture, it will doubtless prove of vast importance. Mr. Ashcroft tried it on the South-Eastern Railway for nearly two years experimentally, and, we are informed, reported in favour of it.

McOny.—We do not know, and have been unsuccessful in our inquiries, for the address of Mr. Lewsey. We remember seeing his wrought-iron system of framing sugar mills applied in a model machine, and we had also drawings of it, which were obtained for a West Indian correspondent, but we cannot find any tracing or copy of them.

Cyclops.—We advise you to apply the puddled or wrought-steel plates manufactured at the Mersey Forge, Liverpool. The prices are, we understand, from £22 to £25 per ton for what they call best boiler plate; and the angle steel which you require would cost about £16 per ton. Write them direct.

R. P. (Birmingham).—Your letter, dated 23rd November, does not supply us with the means of communicating with you through the post. This is very stupid, considering the urgency of your request. We wish correspondents would take a little trouble, and think for themselves before writing fo information such as you require. As to your postscript, we advise you to apply to Messrs. W. Smith and Rollason, Bromford Mills, Erdington, near Birmingham. Cast-steel wire is undoubtedly the thing.

[Other Correspondents, to whom we have not replied, must either stand over until next month or again write to us, with their addresses, &c.—ED.]

CORRESPONDENCE.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]—ED.

STEAM-SHIP PROPULSION, &c.

[WE have again received numerous letters respecting the above subject and its collateral branches, which have for so long a period occupied a portion of our space, and from the communications received during the past month we select the two following, with the intention of closing the discussion with the present Number, and availing ourselves of the earliest opportunity of reviewing the entire subject, and giving a *resumé* thereof, with the view of rendering, as far as possible, practically useful the vast amount of valuable information which has in the course of this discussion been brought forward by our many talented and enthusiastic contributors; some of whose communications contain data which otherwise might never have been brought before our readers but for the spirit and temper which have been infused in the discussion.—ED.]

To the Editor of The Artizan.

SIR,—As a practical engineer, I must confess that I do not see how the last letter of "G. J. Y." can be resisted.

Mr. Mansel must read himself up in dynamics before he again ventures to assail such an opponent on that ground. The arguments and figures of "G. J. Y." with reference to the dynamics of the question are, in my opinion, irrefutable: he is *at home* here, while Mr. Mansel is *quite abroad*. "G. J. Y." assumes that work done is, *cæteris paribus*, in proportion to the space through which the weight falls. Mr. Mansel rather shyly disputes this; but he ought to know that all writers agree in calling $\frac{1}{2}\left(\frac{w}{g}\right)v^2$ the accumulated work, or half VIS VIVA; and, by transposition, this expression becomes $\frac{v^2 w}{2g}$; and as $\frac{v^2}{2g} = h\ \frac{1}{2}\left(\frac{w}{g}\right)v^2 = hw$, which is exactly what "G. J. Y." states. Is not the real dynamic difficulty in this? If a body move with a constant velocity, the forces which impel, and those which resist, must be in *æquilibrio*. And here the question of *time* comes in. To me it appears clear that the amount of force *pro* and *con* must be equal in the same *time* for the space moved through in the same time to be constant, but that the space may be variable, according to density of the medium in which the body moves, &c.

But your readers would be interested in the question as one of *applied mechanics;* and here the momentum, *vis viva*, and all considerations of a purely dynamic character, may be abandoned. Indeed, when we see all the force in a steamer (her *vis viva*, so to speak) acquired by two or three revolutions of her screw or paddle-wheels, and taken out of her by her engines being reversed for a few seconds, we at once see the unimportance of the mere dynamic phase of the question.

We will regard then the steam-ship as an instrument employed in removing the water which is in the way of her passage. If propelling pressure be considered constant, it is alleged that power expended × space. But the fallacy of this is instantly seen, because the *instrument* may be so formed as to pass through the fluid with facility, or the reverse. *Now, work done, in all cases, is in proportion to the force expended upon the water.* This force must be again supplied to the instrument in the *same time* as the instrument expends it upon the water, or the velocity cannot be constant. It is clear and indisputable that if the same pressure be applied to two steamers, one of which is broad, deep, and with full ends, and the other narrow, shallow, and with sharp ends, less steam power will be expended by the latter than the former in passing through the same space, notwithstanding the pressure be the same in both instances, and consequently the formula, pressure × space = power, is a fallacy. But taking the same vessel, or instrument, it is found, if pressure be increased fourfold, that velocity will be increased twofold. But if resistance be increased as pressure is increased, no increase of speed could take place. This has been ably argued by "G. J. Y." I am not aware of any fact in all applied mechanics, which is at variance with this view. If increase of wind, or any other cause, were to require any increase of propelling pressure to keep up the speed, we should certainly say that the opposing pressure had increased in the same ratio as the impelling pressure,—and *vice versâ*; but we cannot say that both pressures have varied alike if velocity change in consequence. We improve form, because we know the same pressure, in the same time, may do less work in the same space.

I have already waived dynamic considerations; still there is one which is calculated to throw some light upon the question. Suppose two steamers having velocities as 1 and 2—stop the engines of both, and it will be found that the faster boat will go considerably farther than the other before the momentum is lost. This proves that although the driving pressure is as 1 to 4, the increments of resistance *in the same space* are not in the like ratio; because, if they were, both vessels would be brought to rest *in the same space*. Whether they are in the same time is another question, and one of so complicated and profound a nature that I am not acquainted with the mathematician who can solve it. I once put the question in the simplest form I could devise to a *Cantab*, and he sent me a formula with differential and other symbols beyond my power of integration.

I believe, for my part, that fine-drawn speculations or subtle analyses will never decide the question. It seems to me that broad common-sense views are more likely to subserve the purpose. I think "G. J. Y's" illustrations of the lighter, the horses and the tugs, although put with a levity likely to diminish their effect, much more conclusive than algebraic processes in which an error

of fundamental misconception may be fatal to the whole chain of sequences. Two men may row an eight-oared gig half as fast as her entire crew. The manual labor to row the double distance in the same time would thus be four-fold, and not eightfold, as the "cube theory" would make it. I asked an eminent engineer if he would sign a bond to give all our steamers half-speed with one-eighth of their present consumption of coals. He frankly replied "No."

I am, Sir, your obedient servant,

Woolwich, November 13, 1858. "R. T."

STEAM SHIP PROPULSION.

THE SQUARE AND CUBE THEORIES, ETC., ETC.

To the Editor of The Artizan.

Sir,—I have read with great interest the many communications addressed to you upon the above subjects, and published by you in The Artizan during the last two years or more. Not the least valuable communications were those by Mr. R. Armstrong, whose devotion to the subject and great industry in collecting and tabulating information in the earlier period of its discussion in The Artizan, entitle him to the thanks of those of your readers who have taken the trouble of translating and properly applying for themselves what he so industriously laboured to collect, and whose enthusiastic spirit ushered them forth as triumphantly conclusive facts and figures in support of his views; views which, if I mistake not, had they been rightly understood, are not after all so much at variance with the actual condition of things; and which, moreover, might have been made more thoroughly apparent, had there been a little more kindly feeling displayed towards him by at least one of the heads of the engineering profession, as when, at the conclusion of the discussion of Mr. Armstrong's paper on "High-Speed Navigation," &c., read at the Institution of Civil Engineers, he was treated somewhat rudely by the chairman upon that occasion, notwithstanding that the paper had been received by the Council as a fit and proper paper to be read and discussed at their Institution.

I do not wish to undertake the defence of Mr. Armstrong's views upon the question treated by him in that paper, and in the several communications he addressed to The Artizan, but I must give my testimony to the value of the many and laboriously worked out details which Mr. Armstrong has contributed; and further, that I have been able to make use of them, and in applying and working out much of the matter so contributed I have done so successfully, and have been able practically to verify the results, and with your permission will, at some future time, submit to you for publication, if you please, a paper upon this subject, which, if possessing no other merit, will, I believe, be found strictly correct, and available for marine engineers and ship-builders.

Great men in many professions affect great mystery about that in which they are engaged, and not the least extraordinary instance of this is the last case which has come under my observation, and I cite in illustration the following letter which I have just seen in the scientific journal to which it was addressed:—

"RESISTANCE OF SHIPS.

"*To the Editors of the* 'Philosophical Magazine and Journal.'

"Gentlemen,—In the course of last year there was communicated to me *in confidence*, the results of a great body of experiments on the engine power required to propel steam ships of various sizes and figures at various speeds. From those results I deduced a general formula for the resistance of ships, having such figures as usually occur in steamships, which on the 23rd of December, 1857, I communicated to the owner of the experimental data, and he has since applied it to practice with complete success.

"As the experimental data were given me in confidence, I am, for the present, bound in honour not to disclose the formula which I deduced from them; but as I am desirous not to delay longer the placing it upon record, I have recourse to the old fashion of sending it to you in the form of an anagram, in which the letters that occur in its verbal statement are arranged in alphabetical order, and the number of times that each letter occurs is expressed by figures:—

20 A. 4 B. 6 C. 9 D. 33 E. 8 F. 4 G. 16 H. 10 I. 5 L. 3 M. 15 N. 14 O. 4 P. 3 Q. 14 R. 13 S. 25 T. 4 U. 2 V. 2 W. 1 X. 4 Y. (219 letters in all).

"I hope I may soon be released from my present obligation to secrecy.

"I am, Gentlemen, your most obedient servant,

"*Glasgow*, August 26, 1858." "W. J. Macquorn Rankine.

The above is a very amusing instance of the weakness of great men;—perhaps, also, I should add more distinctly, of their vanity.

I did, ere this anagrammatical letter of Professor Rankine's had been read by me, fondly, and perhaps foolishly, believe in the existence of a republic of scientific information, especially that kind of information practically useful and requisite for developing material progress in one of the great branches of industry and of practical excellence, for which this country has always been pre-eminent. Perhaps, however, I do Professor Rankine and his client great injustice, by even in thought wishing to wrest from them their great secret, which, perhaps, some contemplated change in the law relating to patents for inventions, shortly to be made, may enable them to secure to themselves the application of the formulæ which the talent of the worthy Professor has enabled him to deduce from the actual experiments referred to.

I must add that I hope, for the credit and reputation of a high and worthy member of the mechanical engineering craft residing not a hundred miles from Glasgow, who has Nae-peer amongst the ship-builders and marine engineers of the North, has been wrongly assumed to be the bar to the great discovery, announced so ostentatiously and anagrammatically, from being made available as a contribution to practical science;—which, if it were so, would certainly be unworthy of the man, and of the free-trade spirit which pervades, and which marks the state of scientific knowledge in the latter half of the nineteenth century.

I am, Sir, yours

Chatham. Engineer, R.N.

BREECH-LOADING FIRE-ARMS.

To the Editor of The Artizan.

Sir,—Mr. Prince having appealed to you "in the name of justice" to insert his remarks in reply to a review of "Dean's Rifle Manual" in your impression of October, I beg to claim the same privilege.

1st. My invention is entirely different from any breech-loading principle patented at home or abroad previous to the date of my own.

2ndly. I have *never* had a barrel spoiled in the regular proof, and my barrels go to the proof-house with the breech-loading part in them, quite like a common muzzle-loading gun; and I am not obliged, like Mr. Prince, to have my barrels previously stocked—his being a sliding barrel, attached to the rest of the gun by means of a trombone handle.

3rdly. Mr. J. Prince must frequently use explosive paper, which of course is highly objectionable, because it is dangerous.

All these points herein mentioned are established officially, and open to public investigation; I therefore deem all his utterly unfounded statements as quite unworthy of any controversy, but for the sake of the public in general, who might be misled by such—I cannot help designating them any otherwise than as "barefaced misrepresentations"—I shall be very glad if Mr. J. Prince will carry out his suggestion of a trial, shooting before unbiassed judges, when I shall make only one condition, viz., that both our arms should be shot by strangers, appointed on the spot by the umpires. Mr. J. Prince, for reasons, I suppose, best known to himself, never allowed anybody but himself to shoot his gun at all official trials at Hythe, Enfield, and Woolwich.

I have the honour to be, Sir, your obedient servant,

Wm. Terry.

RAILWAY ACCIDENTS, etc., IN AMERICA.

To the Editor of The Artizau.

Sir,—I last month sent you a few observations on the above subject, and I am now enabled in continuation to send you a few jottings concerning boiler explosions, and also the particulars of the launch of a sloop of war from the Philadelphia Navy Yard this month.

I hope next to be able to forward you some other particulars. You will perceive that England is not the only country in which boiler explosions and railway accidents occur.—I am, Sir, your obedient servant,

An American Engineer.

In the "Philadelphia Ledger," of October 4th, it is stated that the steamer *Barclay* exploded one of her flues on the 3rd inst., about ten miles above Philadelphia. The boat was enveloped in steam, and much consternation was occasioned among the passengers, but no person was injured.

In the "Philadelphia Press," of October 7th, it is stated that a boiler in a small mill at Waupekonetta, Ohio, exploded on September 30th, killing one person, and injuring several others. The boiler was thrown 1,000 ft. from the mill.

The "Philadelphia Press," of October 11th, states, the freight steamer *Hercules*, on the St. Lawrence, from Montreal, blew up on the 9th inst., 18 miles below Ogdenburg. All the crew are missing except two, who are so badly burned that it is doubtful whether they will survive.

The "Philadelphia Press," of October 15th, contains the statement, that the steamer *Canada* collapsed her flues in Saginaw river, Michigan, on the 13th. Three of the crew were scalded to death.

We also find in the "Philadelphia Press," of October 19th, that the steam-tug *T. H. Bloore* exploded her boiler outside of Oswego harbour on the 18th. Four persons were badly hurt, and the engineer is missing.

The "Philadelphia Press," of October 11th, states particulars of a collision. Two freight trains on the Ohio and Mississippi rivers came in collision on the night of the 8th inst. A conductor, engineer, fireman, and brakesman were killed. The boilers and machinery were damaged.

We also learn that the night express train on the New York and Buffalo railroad was thrown off the track on the morning of the 28th ult., about a mile east of Corresus, caused by the spreading of the track; five persons were killed, eight seriously wounded, and several others slightly injured.

The sloop-of-war, *Lancaster*, was launched from the Philadelphia Navy Yard on the 20th October. Her length over all is 273 ft. 1 in.; spar deck, 273 ft.; breadth of beam, 43 ft.; tounage, 2,250 tons. She will carry eighteen 9-in. guns, and two 11-in. The engines by Messrs. Reaney and Neafie, of Philadelphia, have each one cylinder 61 in. diameter, 33 in. stroke, fitted with Martin's boiler, with vertical tubes. The propeller is two blades, 15 ft. 6 in. diameter, pitch increasing from the hub to the circumference—mean pitch, 26 ft.; length of blade, fore and aft. 3 ft. 3 in. She is named after the native town of President Buchanan, and was christened by the President's niece, Miss Harriet Lane, with a bottle of wine made from grapes raised in the neighbourhood of Lancaster.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artisan.

With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.—Ed.

The Suffocation by Gas of the Family at Newport.—The inquest on the father and three children, who were suffocated by an escape of gas in their miserable dwelling in Pillgwenlly, terminated on the 2nd November ult. An attempt was made, on behalf of the Gas Company, to shift any blame in the disaster from themselves to the Town Surveyor, whose duty, according to Mr. Bryan (their manager), was to see "that such gas-pipes as were distributed in making the drains were properly re-deposited, and the earth which had been removed rammed under them again in a proper manner,"—a proposition from which the Coroner entirely dissented, "believing it to be his and the Company's duty to see to the pipes; therefore the witness should not attempt to put it off upon the Town Surveyor." A feeble attempt was then made to ascribe the catastrophe "to the presence of sulphuretted hydrogen gas, the product of putrid animal and vegetable matter, a gas very common and prevalent in low marshy land." "He (witness) had frequently been called in to examine for leaks of gas, which eventually had proved to be this kind of gas" (not carburetted hydrogen from gas-works). The Coroner having observed that it appeared still to be a matter of doubt whether death resulted from carburetted hydrogen or sulphuretted hydrogen, one of the witnesses remarked, "There can be no question about it—death resulted from gas made from coal." Verdict, "That the deceased died from suffocation, accidentally caused by inhaling carburetted hydrogen gas;" annexing, as the Jury's decided opinion, "that there had been gross carelessness either on the part of the Gas Company or the contractor for the drainage, or both, though, from the absence of any direct evidence, they (the Jury) were unable to determine upon which party the blame should rest; and we recommend both the Gas Company and the contractor for the drainage to be more careful in future operations."

Infraction of Colliery Rules.—The owner of the Cyfing Colliery, near Swansea, was charged (4th November ult.) before the magistrates assembled in petty sessions at Swansea, and on the information of the Government Inspector of Collieries (in connexion with the recent disastrous explosion at the Cyfing Colliery, near that town), with several infractions of the rules for the management of collieries, viz.:—1st, for not providing the steam boiler of the colliery with a proper steam-guage; 2nd, for not having an adequate break attached to every machine used for lowering or raising persons in the pit; 3rd, for not having a proper indicator, to show the position of the load in the pit or shaft; 4th, for not having an adequate amount of ventilation in the pit. The defendant pleaded "guilty" to the first three of these charges, but denied the charge of insufficient ventilation. The defendant's answer to the charge was, that he had left these matters to his manager, and he had thought they were properly attended to. The Bench inflicted the full penalty in each of the three cases to which defendant had pleaded guilty, the fourth charge not being pressed. The manager of the colliery was then charged with violating the rules of the 18th and 19th Victoria, by neglecting to give a copy of the rules to each man in the pit. The proprietor of the pit proved that he supplied the defendant (his manager) with printed copies of the rules, in English and Welsh; and the Government Inspector proved that, on the inquest on the six men killed by the explosion, he (the manager) could not recollect giving a copy of the rules to any of the colliers excepting one of them. The magistrates inflicted the full penalty of £5 and costs in each case.

Court-Martial—Grounding of the "Urgent" Steam Troop-Ship.—The court-martial, Rear-Admiral the Hon. George Grey, President, assembled (9th November ult.) on board the *Victory*, in Portsmouth harbour, to try the master of H.M. steam troop-ship *Urgent*, for negligently navigating that vessel, whereby she took the ground off Chichester on the night of the 1st November ult., announced their opinion, after full inquiry into the cause of the accident, "that sufficient allowance was not made for the speed of the ship and set of the tide between 5·50 and 6·50 on the evening in question; but, as the commander and master showed great anxiety and attention to their duty on that occasion, the Court only recommended them to be more cautious for the future.

The Smoke Nuisance—Steamers.—On the 28th October ult. the first summons under the new Act, as against the master of a below-bridge steamer, was disposed of by Mr. Yardley, at the Thames Police Court. The summons, taken out by the Superintendent of the K division of Police, by order of the Secretary of State, was against the master of the steam towing-vessel *Magnet*, and charged him with "unlawfully using in the working of the said steam-vessel *Magnet*, on the river Thames, below London Bridge, a certain steam-engine and funnel not constructed so as to consume or burn its own smoke." At the hearing the owner of the vessel stated, through his solicitor, that he had advised the defendant to plead "not guilty," believing that the Act of Parliament applied to steam-boats *above* bridge only; but since he had come into court he had seen a recent Act of Parliament which applied to steam-boats *below* London Bridge. At the hearing, therefore, the defendant, by his advice, pleaded "guilty." On the part of the Crown, Mr. Bodkin said all steamers navigating the Thames west of the Nore Light must consume or burn their own smoke, as far as was practicable. The owner, through his solicitor, then undertook to put up a proper apparatus to consume or burn the smoke; he had already, it was stated, commenced burning anthracite coal, and the little smoke that came from it went up with the steam. For the Crown it was replied, that no dependance could be placed on any coal. The only remedy was to apply an apparatus to consume or burn the smoke. A man had lately used three sorts of fuel, which he thought gave out no smoke, and was deceived; and, in burning it, said he could not get up the steam. Owners of steamers below London Bridge had only to look at the steamers plying above bridge, in which the most beautiful arrangements were made to consume smoke; and there was no more smoke emitted from the chimney of each steamer than what came from a man's cigar while he was smoking it. The magistrate, after remarking that this was the first summons that had been issued against the master of a below-bridge steamer, and that the Act of Parliament could not be too generally known, inflicted the minimum penalty (of 40s.) only, the maximum penalty for each offence being £5.

Fireworks—Manufacture Illegal.—At Lambeth Police Office (1st November ult.) a firework manufacturer in the Westminster road was, at the instance of the Sanitary Inspector of the Parish of St. George, Southwark, fined £5 and costs for selling fireworks; the magistrate, Mr. Elliott, declaring that the practice of manufacturing and selling fireworks was highly dangerous, and ought to be put a stop to.

The Brent Reservoir.—In the year 1851, the Regent's Canal Company obtained an Act of Parliament enabling them to enlarge a reservoir belonging to them, situate on the river Brent at Hendley, in Middlesex, and a portion of land was taken by the Company for the purposes of their Act. The owner of this land (Mr. Hare), dissatisfied with the subsequent engineering proceedings as affecting the remaining portion of his estate, not taken, filed his bill against the Company, alleging, as the ground of his complaint, that the embankment of the Reservoir had been raised 3 ft. higher than it ought to be, according to the plan deposited by the defendants with Parliament on obtaining their bill; and that the works at the overflow had been so constructed as to admit of the Company, at their pleasure, raising the top-water level 1 ft. 6 in. above the line laid down on the Parliamentary plan. In consequence of this deviation from the mode of construction authorized by the Legislature, plaintiff alleged that a considerable portion of his land, not taken by the Company under the powers of their Act, had been frequently flooded, and remained covered by the waters of the Reservoir for a considerable time, and had been greatly damaged and rendered nearly valueless by such soakage. He, therefore, prayed an injunction to restrain the defendants from erecting or raising any part of their embankment of the Canal or dam of the Reservoir, at Hendley, either temporarily or permanently, higher than 38 ft., as shown on the deposited Parliamentary plan and sections, so that either by the overflow of the rivers Orwell or Trent, or overflow of the water in the Canal, the plaintiff's surplus lands, not taken by the Company, would be overflowed or submerged and injured to a greater extent than they would be if the embankments to be constructed were only raised 35 ft. 9 in. in terms of the Act of Parliament. He also asked by his bill for compensation for the loss and inconvenience sustained by him. The Master of the Rolls dismissed the bill, with costs, on the ground that a court of law was the proper place for plaintiff to obtain compensation. From this decision the plaintiff has appealed; and the case came, on appeal, before the Lord Chancellor, who (15th November ult.) after reviewing the evidence of the engineers, and examining the plans, sections, &c., referred to, refused the injunction, and dismissed the appeal with costs.

The Primrose Pit Catastrophe.—Returned Air from Boilers.—Caution to "Firemen."—The adjourned inquest upon the bodies of the fourteen men who were killed by suffocation in Swansea Valley, on the 13th October ult. (see "Notes and Novelties" for last month), was resumed on the 25th October ult. The Government Inspector for South Wales stated there could be no doubt that the accident arose from the door being left open under the level of the crossing, and which separated the one air from the other; the air was then reversed, and, instead of going the usual way, filled both levels. It seemed strange that lighted candles (a fact proved in the course of this inquiry) should burn where the men were suffocated; but he found, from the published reports of the Inspectors of Mines, that two similar cases were recorded, where the return air from the boiler had caused death. There was no question that the pit was well ventilated; "the accident undoubtedly arose from the opening of the door near the boilers," allowing, as otherwise proved, the smoke from the boilers to return into the workings.—Verdict, "Accidental Death," caused by the opening of the door upon the level; but by whom this was done there was no evidence to show. The "overman" of the Colliery attributed the fatal accident to what he described, in workman-phrase, as "the sulphur from the engine,"—adding that "the door of the underground boiler was fastened with a link and staple, and in such a manner that somebody must have opened it—it could not open itself." One peculiarity in this otherwise remarkable case, was the fact (upon which it appears great stress was laid by more than one scientific witness present on the inquiry), that "some naked lamps" or "lighted candles" were found burning where the men were suffocated. This apparent anomaly was, as we have seen remarked upon, but not explained by the Government Inspector, who merely corroborated the possibility of an occurrence, the *rationale* of which seems to merit further investigation;—the hitherto popularly at least received notion amongst miners being, we believe, that, what will support light will also support life, and *vice versâ*,—the practical basis of the usual and well-known expedient of testing the safety of a suspected pit by lowering a lighted taper, which, if it continue to burn, is considered (how truly, will be henceforth the question) to afford a sufficient proof of the salubrity of the air contained.

Imitation of Trade (Patent) Marks.—The Court of Exchequer has recently held that in an action to recover penalties for the imitation of a patent article, under the 5th & 6th William IV. cap. 83, sec. 7, the fact of intention of imitating must be proved. In this case [Myers and another *v.* Baker and another] both parties, plaintiffs and defendants, were manufacturers of steel pens at Birmingham. At the trial before the Lord Chief Justice of the Common Pleas, at Warwick, his Lordship had left it to the jury whether there was an imitation, and if so, whether it was done with the intention of imitating the plaintiffs' patent. The jury found for the defendants generally, and a rule was afterwards obtained for a new trial on the ground of misdirection, namely: that the jury should have been told that the offence was established on proof being given that the article manufactured by the defendants bore the word "Patent." On showing cause against this rule for a new trial, counsel for the defendants contended that there had been no intention to imitate, and that was the essence of the offence. The Lord Chief Baron refused to grant the new trial moved for, adding, "In this case, the jury ignored the intention to defraud, and thought the defendants had acted with perfect *bona fides*. There must be an intention before a person could be liable to penalties." Mr. Baron Bramwell had previously remarked, that if the penalties alluded to in the course of the argument (£50 on each pen in the 10,000 gross manufactured) were enforced, they would amount to £7,000,200.

Bridge Tolls liable to Land-tax.—The Court of Queen's Bench has recently (23d November ult.) decided that the land tax, being raised for the purpose of meeting the national burdens, admitted of no exemption; that, therefore, the Waterloo Bridge Company (who had disputed their liability on the ground of the tax in question being an assessed tax, from which they were exempted by their Act of Parliament) were liable to the claim for land-tax made against them by the collector, on behalf of the parish of St. Clement Danes, within which the north end of the bridge was situated.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from Correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed, "18, Salisbury-street, Adelphi, London, W.C.," and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Wood Embossing.—This invention, termed by its author, M. Amies, *placage en relief*, consists in placing thin plates of wood (veneers) between two matrices or dies, one of them bearing, in relief, the figure or ornament to be produced; and the other, the same figure, sunk or indented. Both dies are gently heated, and the thin sheet of wood between them is subjected to a high pressure: so that when taken from the mould, it bears on its upper surface a sharp impression, having indeed the appearance of a real carving in wood. The hollows are filled up with a plastic substance, such as mastic, papier mâché (in pulp), &c., or any similar composition; and when dried and polished the ornament may be fixed on any article of furniture, &c. The details of manipulation are as follows:—the veneers, first cut to the proper dimensions, are to be well polished on the upper side to erase any saw-marks or other inequalities, and then to be sand-papered on the under side, to which is to be pasted a lining or sheet of paper: the wood is then left for a time to absorb a portion of the paste; whilst still damp the sheet is now placed between the halves of the mould,

heated as above directed, and submitted to the action of a powerful press. The ornament is to be left in the hot mould until the wood, paste and paper have become perfectly dry, when it will be found that by the joint action of the press, the heat and the pasted paper, the wood will have been reduced to so plastic and yielding a state as to accommodate itself perfectly and permanently to the figures in the matrices, both in relief and indention. The filling up of the hollows with mastic, &c., completes the process, and effectually prevents any subsequent change of form, as by splitting, shrinking, &c., in the substance of the wood. The inventor in describing his process, which he terms "*placage en rélief*," otherwise, we believe, now known as "xyloplasty," *i. e.* wood-embossing, adds, that experience has shown that ordinary flour paste is better adapted than glue for the undercoating, and he recommends the use of common writing-paper for the lining.

Sewing Machines have lately been introduced into the army-tailoring department at Woolwich, and it is expected they will henceforth be used to a large extent.

Shipping-trade of France and England.—The following is the amount of tonnage (French and Foreign), which entered the ports of France in the last three years:—

	French.	Foreign.
1855	1,248,086	2,054,482
1856	1,465,561	2,609,342
1857	1,660,064	2,484,472
Total	4,374,011	7,148,296
Average	1,358,004	2,382,765
Excess (Foreign)		924,761

Amount of Tonnage (English and Foreign) which entered our ports in the same three years:—

	English.	Foreign.
1855	4,174,082	2,844,386
1856	5,085,910	3,135,793
1857	5,418,090	3,314,090
Total	14,678,082	9,294,269
Average	4,892,694	3,098,089
Excess (English)		1,794,605

Thus, of the whole tonnage engaged in the highly *protected* import trade of France, the foreign exceeds the native by more than one-half, or 63 per cent.: whilst, in our *unprotected* trade, the amount of foreign tonnage is only equal to 61 per cent. of the native tonnage.

Greenwich Time.—Lord Wrottesley has lately erected at his observatory, near Wolverhampton, a large time-ball to indicate true Greenwich time. The ball is between 4 and 5 ft. in diameter, and is elevated 60 feet from the ground: it will be raised 15 minutes before 3 o'clock on Tuesdays and Saturdays, and will fall exactly (query, by electric agency ?) at 3 o'clock, Greenwich time.

A "Pantagraphic Carving and Cutting Machine" would appear to be no very promising speculation, at least in a mercantile point of view. In a recent bankruptcy case, a "round item of £5,000" appeared on the credit side of the balance-sheet: but this item merely represented the bankrupt's "interest" in a patent for the above mentioned machine, whatever that may be; and the official assignee stated that "there were literally no assets."

The "Podoscaphs," for walking on water, to the invention of which, by M. Ochsner, of Rotterdam, we formerly alluded, are a species of sabot (or wooden shoe), about 15 ft. long and 9 in. high (or deep). Standing erect, the "Podoscapher," provided with a pole, flattened at the end (for paddling), and 12 ft. long, can advance, turn or recede, with great swiftness, in water not deeper than the length of the pole. M. Ochsner recently won a wager by ascending the Rhine from Rotterdam to Cologne, in his Podoscaphs, in seven days.

Collapse of Flues.—The question of the resistance of thin tubes to collapse has recently occupied the attention of practical men; and some important facts, hitherto unremarked, or but partially investigated, have been brought to light. Mr. Fairbairn finds that the intensity of the pressure required to make a flue or other thin tube collapse, is directly as the square of the thickness, nearly inversely as the diameter, and *inversely as the length*. The diminution of the strength of a flue, as the length increases, is a law never before, it would appear, suspected. For computing the pressure, in pounds on the square inch which a wrought-iron flue can sustain, the following rule is sufficiently near the truth for practical purposes:—Multiply the constant factor 806,000 by the square of the thickness, in inches; and divide by the product of the length in feet, and diameter in inches. It is of great importance to strength that the flue should be as cylindrical as possible.

Steam Hammers.—Upwards of 100 tons of Condie's Patent "Moving Cylinder" Steam-hammers have been sent to Russia during the last four months.

The Great Bell of the Clock of the new Palace at Westminster was (18th November ult.) rung for the first time, in its final position in the Clock tower. It was not struck with the ponderous hammer to be used when the clock is finished, but was tolled with the large clapper only, henceforth to be used, as in the instance of St. Paul's, on occasions of public mourning. The vibration of the octagon collar and of the cast-iron standards was so violent as to show the necessity for adding supports to the frame and wrought-iron brackets, a precaution which, it is understood, will immediately be adopted. Instead of hanging by a hook, and being thus allowed to swing freely, the great Bell is rigidly and firmly bolted to the iron beam by which it is supported; in this arrangement, likewise, an alteration will be effected.

RAILWAYS, &c.

The Luxembourg Railway was opened on the 27th October ult. It runs through the highly picturesque, but hitherto wild and, comparatively, unfrequented district of the Ardennes. Its construction had presented an unusual, if not unprecedented series of engineering difficulties, including the perforation of rocks for a distance of nearly 15 leagues, the filling up of extraordinary depths, chasms, &c., and the levelling of extensive surfaces of granite, through a country which has been designated by some geographers as "the *Steppes* of Europe." The inauguration was celebrated with great splendour, the townspeople of Arlon having, as their share of the expenses, voted a credit of 40,000 francs for lodging, feasting and entertaining the numerous and distinguished personages invited to the opening. Amongst these, and accompanying his majesty the King of Belgium, were the Governor of the Province of Namur, the Governor of Luxembourg, the Deputies of the Province, the Ministers of the Interior, of Finance, of Foreign Affairs, and of War, who, with the princes and great officers of the household, arrived 1·20 p.m. in the royal train, at Arlon, having started from Brussels at 6·30 a.m., passing through Gembloux, Namur, Ciney (the Ardennes), Aye, Libramont, Poix, Jemelle, and Rocoigne. In the royal train were Mr. Scott, the (English) Director of the Company, and the other Directors. At the Arlon station, or rather, on the spot where it will shortly be, were the Governor Commandant, Commandant de Place, &c., of the Federative Fortress of Luxembourg, the (local) President of the Council, and the Prefect of Metz and Sous-Prefect of Malmedy, "on a special mission, charged by their sovereigns to congratulate the King of the Belgians on the occasion."

Australian Lines.—Recent advices state that the Railway-works (near Melbourne) have been interrupted by strikes, caused (says the "Melbourne Argus,") partly by the unfair treatment of the contractors, and partly by the unreasonable demands of the workmen, labour being (15 September ult.) still much in excess of the demand. The President of the Board of Land and Works had officially stated that he would insist on the contractors employing the full complement of hands, so that the construction of the works should proceed with the required speed.

India.—Futtehpore and Cawnpore.—The completion of this Railway is announced. An experimental train was started from the former place on the 10th September ult. Railway communication, therefore, between Allahabad and Cawnpore is effected, strengthening our military position, and promising a considerable saving of time and expense in moving troops. It was expected that the line would be thrown open to traffic in a few days.

East Indian Railway.—From last report (meeting held 28th October ult.), it appears that 121½ miles of Railway have been opened since 1851, and that a further length of 126 miles have been just completed; the remaining 45 miles are to be finished by the end of 1859.

Cape of Good Hope (Interior) Railway.—The "Examiner" (November 13th) announces "a civil engineer is gone out" (query, from whence?) "in the Cape of Good Hope mail packet, *Athens*, to superintend the formation of a Railway at the Cape, 80 miles long, into the interior."

Attempts to upset Railway-trains have occurred during the past month.—On the 1st November ult. a returned convict, a labourer, employed to repair rails near the junction of the Blackburn Valley Line with the Rotherham Line, was charged at the Rotherham Court house with having maliciously laid a stout iron crow-bar across the line. A train from Sheffield to Dorchester, passing over it, was shaken violently, the bar cut in two and bent, and a piece of the rail itself broken.—At the Uttoxeter Petty Sessions a man was charged with "feloniously putting an iron railway-chair on the rails of the North Staffordshire Railway, between Bromshall and Leigh stations, with intent to endanger the safety of persons travelling thereon." The accused was seen near the line about the time the obstruction was discovered (by the driver of the 8 p.m. express to Uttoxeter), and on his apprehension he admitted that he did it "to try if the engine would throw it off." The iron-chair weighed 28 lbs. He stands committed for trial at the next assizes.

A North and South London Railway has been started. It is intended to form a junction between the lines on the North side of London, and those on the South by the construction of a short link from the terminus of the West London Railway, at the Kensington Canal Basin which will cross the Thames at Battersea, to the West-end and Crystal Palace line on Wandsworth common.

A Fatal Accident occurred, 1st November ult., on the Ambergate branch of the Midland Railway. Two persons killed. Near the Matlock bridge a lady incautiously attempted to cross the line, a railway porter, perceiving her danger, as a train was approaching the station, attempted to pull her back. The engine of the approaching train caught hold of both of them, knocked them down, and the train passed over them; they were both killed, the porter's head being severed from his body. November 2nd. Verdict, "Accidental death," and that no blame was attached to the railway company.

Collision in a Tunnel.—On the afternoon of the 2nd November ult., a railway collision occurred in the tunnel leading from the Great Centre Station, in New street, Birmingham, on the Stour Valley line. The Oxford, Worcester, and Wolverhampton train had got more than half way through the tunnel, when the driver suddenly perceived some obstruction a few yards a-head, but before he could do more than sound his danger-signal, and apply the break, a violent collision took place. Fortunately, his train was not travelling at a very rapid rate, the upward gradient of the tunnel being somewhat steep, and the rails slippery. Beyond considerable fright and a few contusions, no serious damage ensued either to passengers, engine or carriages. The accident arose from part of a train of trucks laden with iron-ore having (most dangerously and carelessly, as it would appear) been left standing on the rails; the driver, finding his engine not equal to its task, and that his train had come to a stand when about three-fourths through the tunnel, having adopted the dangerous course of dividing his train into two parts, intending to shunt the first half on a siding 50 or 100 yards farther on, and then to return for the remainder. The signal man, unaware of what had taken place, telegraphed as usual that the tunnel was clear, and before the driver of the mineral train could return with his engine for the trucks, the other train had entered the tunnel, and hence the collision.

Metropolitan Railway.—The application of the directors to the Quarter Sessions for Middlesex, in May last, for leave to drive a tunnel under the Coldbath-fields House of Correction, having been referred to a special committee, the latter have just made their report, wherein they state that the proposed tunnel "appears to them to be in every respect objectionable;" that the committee have sought the advice of Mr. George P. Bidder on the subject, and that on the 8th July they received from him an elaborate report, wherein he expressed an opinion that the proposal to carry the railway under the prison is practicable, but as it would have to be carried out in the first instance by an open cutting, protected during the progress of the work by a moveable iron shield—the roof of the tunnel being only 7 ft. at one point below the surface of the prison ground—involving the construction and readjustment of a considerable portion of the drains, and so much difficulty in the management and discipline of the prison, they had advised the directors so to deviate the line of the proposed railway as to avoid the prison altogether, with which recommendation the directors had (on the 24th September) complied, at the same time intimating their intention to apply in the next session of Parliament for powers to deviate their line accordingly. By the original Act (17 and 18 Vict. cap. 221) the company were empowered to take the prison for the purposes of their railway within three years after the 7th of August 1854: and by the 19th and 20th Vict. cap. 119, the time was extended one year; so that their powers lapsed on the 7th of August last.

Irish Railways.—Surveys are being made for the line from Monoghan to Clones.

Clones to Cavan.—A line from these points is also projected.

Dungarvon and Clonmel.—This railway will be twenty-eight miles in length. Cost of construction, £7,000. per mile.

Dublin and Meath.—The first sod of this railway, which opens up direct communication with Navan, has been turned by his Grace the Duke of Leinster, to whom a beautiful spade of solid silver, a wheel-barrow of Irish oak, with silver mountings, &c., &c., were presented. Engineer, Sir John McNeill. Contractors, Messrs. Patrick, John and Edward Moore.

The Waterford and Limerick Railway is about to be transferred (under certain conditions, providing for the protection of the port of Waterford) to the Great Southern and Western Company.

A Berar and Eastern Coast of India Railway Company, proposed capital £3,000,000, in 150,000 shares, has been started, subject, however, to obtaining the grant of a government guarantee. The projected line is to run from the Port of Coringa (at the mouth of the Godavery, midway between Calcutta and Madras), viâ Chinoor and Chanda, to Nagpore, with a branch line to the city of Hyderabad: ultimately connecting the line with the Madras and Bombay Trunk Railways. Total length of main line from Coringa to Nagpore about 400 miles. Estimated cost of construction £8,000. per mile. The traffic estimates appear to be founded on the alleged probable opening up of rich cotton fields.

From the Amoor to the Gulf of Castries.—The Russian engineers propose to their government the construction of a railway from a point on the River Amoor, some miles above its junction with the ocean. Before it disembogues into the Gulf of Nicolajaw, this mighty stream approaches the sea by a bend, so as to be only 60 versts, or 40 miles from the Gulf of Castries, a part of the coast so named by the celebrated navigator, La Perouse, in honour of Castries who was then French Ministre de Marine. To avoid the banks of sand at the junction of the Amoor with the ocean, the present railway is recommended from the admirable roadstead in question. The exploring steam-frigate *Amerika*, by th report of its Russian captain, found a still more serviceable bay further south, opposite th Japanese island of Matzmai; and no similar craft had ever been seen in these waters.

The Lucca and Pisa Railway, with its stations, engines, rolling-stock, &c., &c., is advertized to be sold by auction at Lucca, on the 9th of December, 1858.

Great India Peninsula.—Of the 1,235½ miles of railway undertaken to be constructed by this company in Western India, there are 130½ miles now open for public traffic, 732¼ miles under contract for construction, and 372¾ miles unlet. The portions under contract extend in a south-east direction on the Bhore Ghât 13¾ miles; and from Poonah to Sholapore 163 miles; in a north-east direction, from Wassind to Jubbalpore 556 miles. The Bhore Ghât incline (13½ miles) is to be completed in February 1861—the contract from Poonah to Sholapore (163 miles) in September 1859—Wassind to Rotundah Nullah (25 miles) in November 1859: the Thull Ghât incline (9 miles) by December 1861—Egutpoore to Bhosawul (190 miles) in June 1860— and from the latter place to Jubbulpore (332 miles) by March 1862. On the 14th June, the line from Khandulla to Poonah (42 miles) was opened for traffic; but from Poonah to the Bheema, the railway is still incomplete, the engineer expecting it to be ready by December then next.

Railway Speed.—Her Majesty made the recent journey from Edinburgh to London (400 miles) in 11 hours, or at the continuous rate of 40 miles an hour.

Fatal Collision on the North British Railway.—Two luggage trains came into collision at the Heriot station of the railway, on the night of the 21st October ult., by which one cattle drover lost his life, and another was considerably injured. The driver, it seems, absconded, after the serious nature of the accident had transpired. The "Edinburgh Express" states that a warrant has been issued by the sheriff for his apprehension.

Railway Accident Prevented.—The judicious management, in a critical emergency, of a railway train, by a guard and engine driver in the service of the North-Eastern Railway Company, has been highly commended. A few days since an express train was proceeding from York to Scarborough, and on taking the curve near Kirkham, several of the carriages and the luggage van went off the rails. The guard promptly put on his break, and the engine driver with commendable presence of mind, instead of shutting off his steam and reversing his engine, gradually drew up his train, keeping it tight, with the coupling irons at stretch. The carriages again righted themselves; and although the van was much shaken and knocked about, no further accident occurred. Had the driver shut off his steam and reversed his engine at once, the momentum of the hinder part of the train would have driven the passenger carriage over the disabled van, and probably, caused a serious calamity.

Railways in Chili.—The Pabellon and Chanarcillo extension of the Copiapo Railway is so far advanced that a trial trip has been made on 12 miles. Some of the inclines have a gradient of 170 to 324 feet in the mile; the terminus is at an elevation of 4,075 feet above the level of the sea;—said to be 1,000 feet higher than any other locomotive has reached. This railway crosses the snow-bound passes of the Andes, thus uniting the coasts with the plains and pampas.

Heights of Railways.—The summit level of the Great Indian Peninsular Railway for traversing the Western Ghauts, has been hitherto considered the highest in the world; that of the Sœmmerang pass, on the Vienna and Trieste Railway, the highest in Europe, is about 3,000 feet above the level of the sea. The highest summit in North America is the pass of the Blue Mountains by the Baltimore and Ohio Railway, about 2,700 feet high. When the Copiapo Railway is extended two miles further, it will have reached 4,479 feet above the level of the Pacific.

The section from Alar del Rey to Reynosa, of the Alar del Rey and Santander Railway (opened on the 25th March, 1857), is the next highest railway in the world. Its respective termini are 3,053 and 3,031 ft. above the mean tide at Santander; while the summit between these is 3,524 ft., or only 551 ft. lower than the Copiapo line, and considerably higher than the Sœmmering Pass of the Vienna and Trieste Railway.

Italian Railways.—Naples to the Adriatic.—The Neapolitan Government has, at length, determined by a royal rescript to undertake the completion of this line of railway; and orders have been sent down to resume the works from St. Severino to Ariano. The original concession was granted to men of straw, with the secret intention—so, at least, it is generally understood—to ensure its failure; and the present apparent resumption of the project by the Government, adverse as it is well known to be to the construction of railways, and to progress in any shape, is believed to be but another phase of the same policy.

Austrian Railways.—The shareholders of the Francis-Joseph Railway have confirmed the fusion with the Lombardy line.

Spanish Railways.—The "Madrid Gazette" (10th November ult.) directs that the concessions of the 1st, 2d, 3d, and 5th sections of the Palencia and Corunna Railroad shall be put up to public adjudication in the course of the next three months. The first section is from Palencia to Leon; the second, from Leon to Ponferroda; the third, from Ponferroda to San Martin de Quiroga; and the fifth, from Lugo to Corunna. A sum of 1,000,000,000 reals is to be at the disposal of the Department of Public Works, to be exclusively employed in railways and common roads.

Madrid and Valence.—The section of this line between Alcudia and Mogante has been concluded, and will shortly be open to the public.

North of Spain Railway.—The works on this line are steadily progressing.

In Catalonia, the utmost vigour is every where visible in railway works.

On the Mont Blanc and Rens line, especially, important works have been executed.

Alicante and Madrid.—An official statement gives the number of travellers on this line, during the month of October, at 10,386; and the receipts, 347,648 reals; being 50 per cent. per kilometre more than the receipts during the same month last year.

The First Turkish Railway.—The line (70 miles long) between Smyrna and Aidin has been partially opened, and Lord Stratford laid, on October 30th, the foundation-stone of the Smyrna station. In his inaugural speech, alluding to the English origin of this line, Lord Stratford remarked—"This railway belongs to another empire, but is equally a type and result of those qualities which characterise, pre-eminently, the English people." Sir Macdonald Stephenson, in explaining the local advantages of the line, stated that the usual cost of bringing tobacco from the interior was 4*s.* per ton per mile; when the railway was made, this tobacco would come to Smyrna at 4*d.* a ton per mile—a saving of one-twelfth, or 22 per cent. The railway would be made for £10,000 or £12,000 per mile, or 75 per cent. less than in England, where, a few years since, railroads cost, on an average, £50,000 a mile.

The New Railway Carriages for the Pope are about to be exhibited at Paris, in the Exhibition Palace of the Champs Elysées. They are so arranged as to form a sort of terrace, an ante-chamber, a throne-room, and a bedroom;—no mention, this time, of an *Oratory.* The decorations are described as most magnificent—replete as they are with first-rate religious paintings (one of the "Immaculate Conception" included), blue hangings and bronze enrichments.

Another Collision occurred recently on the Shields and Newcastle branch of the North-Eastern Railway: the 11 o'clock train from Newcastle to Sunderland and Shields was passing through a deep cutting, approaching a long tunnel which goes underneath the village of Heworth, when the engine broke down. The guard, knowing that a goods' train was following, called upon the passengers to jump out; before they could all escape, however, the goods' train ran into them, and two passengers in a third-class carriage were badly hurt. A first-class carriage was partially thrown across the up-line by the collision, and, the next moment, a Shields and Sunderland train came flying through the tunnel, the engine carrying away the end of the first-class carriage. No further injury, however, appears to have resulted from this double catastrophe.

The West London, hitherto more popularly known as "Punch's Line," appears anxious to assume for the future a more commanding position. At a recent special general meeting it was resolved to make application to Parliament in the ensuing session for an act to extend the Kensington Canal branch across the Thames to the London and South-Western Railway, and also for power to sell the Kensington Canal. The line will then join the London and North-Western, and the Great Western, with all the railways at the south side of the Thames, the South-Eastern, the Brighton, the South-Western, and the Crystal Palace railways.

Madras Railway.—The mileage of this line (open since the 19th May last) is 96 instead of 81 miles, as generally, but inaccurately, stated.

Geelong and Melbourne.—The *Australian Gazette* states that the Colonial Government have promised that the continuation of this line from Williamstown to Melbourne shall be completed in December.

Rhine Railway.—The section between Cologne and Coblentz has been opened to the public.

TELEGRAPH ENGINEERING, &c.

Of the Transatlantic Cable nothing satisfactory has transpired The latest news is that the *Stag*, with 7 miles of the shore end of the cable on board, had (2nd November ult.) arrived in Valentia harbour; a reef of rocks, called the Coast-guard Patch, lies about 1½ mile or 2 miles outside the mouth of Valentia harbour, having on it about 10 fathoms at low water, and about 26 fathoms all round it; the *Agamemnon* was, from stress of weather, obliged to lay the cable over this spot, and it is thought that the drifting of the cable over this place might have caused the injury, &c., &c. The additional 7 miles to be added to the existing 5, would, it was hoped, render the rope quite secure against injury from the wash of the tide.

Submarine Cable to Hanover.—A recent telegraphic despatch from Emden, in Hanover, announces the successful completion of electric communication between that port and the English coast.

Bavaria and Switzerland.—A (recent) Munich letter states that a plan is in contemplation for establishing an electric cable across the Lake of Constance, in order to unite Lindau to Switzerland.

Australia.—The electric telegraph from Adelaide to Melbourne is in full work. The line northward, from Melbourne to Sydney, is in a state of forwardness, the junction to be at Albany. When completed, the colonies of New South Wales, Victoria, and South Australia will have a connecting line of nearly 1000 miles.

Candia.—Her Majesty's steamer *Medina* left Alexandria (8th October ult.) for Candia, for the purpose of assisting in the laying of the submarine telegraph cable.

Telegrams in France.—According to the "Constitutionnel," the number of despatches sent for the public was, in 1852, 48,000; in 1856 it rose to 360,000, and in 1857, to 413,000. In 1852, there were only 45 stations; in 1856 there were 167, and in 1857, 171. In 1852 the receipts from telegraphs were 542,000 fr.; in 1856, 3,191,000 fr., and in 1857, 3,333,000 fr., divided amongst the different stations, thus: Paris 1,466,000 fr., Marseilles 455,000 fr.; and the towns which followed in order of importance were Lyons, Bordeaux, Havre, Nantes, Toulouse, Lille, Rouen, Strasbourg, and Bayonne. The number of towns from which the receipts exceed 10,000 fr. is thirty. The average sum received for each despatch was, in 1857, 8fr. 6c., whilst in 1856, it was 8fr. 83c. The Treasury lost nothing by the reductions which (for the sake of commerce) it made in the charges for despatches; its receipts, on the contrary, increased; thus, whilst the average charge for a despatch was, in 1857, 79c. less than in 1856, the average yield per kilometre rose from 283,000fr. to 291,000fr., an augmentation of more than 1·8 per cent.

Turkey and Egypt.—[*International.*]—October 23rd ult. the Minister of the Interior of Greece was in Constantinople to arrange about the junction of the Telegraph-lines of the two countries.

The Electric Telegraph Company of Ireland have (18th November ult.), through their official manager, invited public tenders for the purchase of their line, plant, and materials.

Ireland—The Irish Magnetic Telegraph Company have contracted with the Midland Great Western Railway for the reconstruction of the line of Telegraph from Dublin to Galway, and also for the erection of wires on the Longford and Cavan branches. The work is to proceed, on the Trunk line, at once; and in a few weeks there will be, it is confidently stated, no cessation of communication between Dublin and Galway.

At Navan and Kells Telegraph stations, for the convenience of the public, are also to be opened forthwith.

Another Transatlantic Cable is (seriously) spoken of. The "New York Herald" states that it is the intention of the British Government to lay a cable between Ireland and Newfoundland, as they "the Britishers" have already experienced the advantage of being placed in direct connection with their colonial possession on this (the American) side of the ocean.

The *Medina*, which left for Candia on the 6th October ult., to meet the steamer with the Telegraph Cable from England, at Canea, had not been heard of at Alexandria up to the 18th. It was well understood that Captain Spratt is totally adverse to the proposed plan of commencing operations at the Alexandrian end of the line; the Cable would, therefore, probably be paid out from the Dardanelles.

Constantinople to Bussora.—A mishap has occurred in laying the wire for this line. After a variety of impediments, the works had begun some six weeks ago at Ismid, in the Gulf of Nicomedia, under Colonel Biddulph, when, after a few days' work, in which the line was completed for about 8 miles, the whole staff was laid up with the fever which no new-comer escapes at that season; the works had, consequently, to be interrupted, and most of those employed had to move away. The completion of the line to Angora before the rainy season being thus rendered impossible, it was decided to begin on the high ground between Sivas and Angora, in both directions; and Lieutenant Holsworth, R.A., has gone down to remove the plant to the last-named place, and begin work there. Colonel Biddulph himself is to start in December, to take the Diarbekir-Bagdad section, in which the winter season is the most favourable for the work.

Constantinople to Cape Hellas.—This land line, which the Turks have undertaken to make in connexion with the Submarine Cable from Alexandria to the latter point, is progressing, but rather slowly; about 39 out of 150 miles are completed, and it may, possibly, be finished before the winter; that is, should the official delays and constitutional apathy of the Turkish Government agents permit.

Calais and Dover.—The "Courier du Pas de Calais" of the 21st October ult. announced that the communications by Submarine Telegraph between these points had been interrupted since 9.20 on the preceding evening. The cause had not as yet been ascertained, "but it appears certain that the cable is broken, the four wires having all failed at the same time." It is thought the rupture must be very near Dover. The telegrams sent by Calais now (21st October) go by the Submarine Telegraph from Ostend to Dover.

The Atlantic Cable.—The *Gorgon*, 6, paddle-sloop, commander Joseph Dayman, which left Woolwich with a numerous party of riggers from the dockyard, to accompany the *Niagara*, and assist in laying down the Atlantic Telegraph Cable, arrived in Woolwich harbour 26th October ult.; her crew are to be paid off.

An Offer to restore the Atlantic Telegraph, on certain conditions, has been made by Mr. G. O. Wildman Whitehouse, late electrician to the Atlantic Telegraph Company, in a (published) letter to the directors, dated Valentia, October 23rd ult., wherein he declares his strong conviction that the Cable is "recoverable—readily recoverable." He therefore undertakes, at his own cost and risk, to re-open communication with Newfoundland, and further, to maintain it for a given number of years at a moderate percentage upon the gross receipts of the company, payable so long as the line shall be kept by him in good working order. This offer has been declined by the company.

TELEGRAPH-WIRES AND POWDER MAGAZINES.—At the request of Marshal Vaillant, Minister of War, who lately addressed the French Academy of Science, requiring their advice whether the passing of the wires of the electric telegraph in the neighbourhood of powder-magazines might not become a source of danger, the question was referred to a committee, who have presented a report, unanimously adopted by the Academy, to the effect that the passage of the electric current through the wires for the ordinary despatch of messages can in no way be the cause of accidents; since, supposing that the wires became broken from any cause whilst the message was passing, the small sparks which would take place at the point of rupture would be insufficient to set fire to any powder which might happen to be deposited even on the wires themselves or the supports; but that as regards atmospheric electricity, its action might possibly be an imminent cause of danger to the powder-magazines; for, if the lightning should strike the wire it is probable it would be fused for a certain distance, and dispersed; and that incandescent globules driven to a distance by the explosion might be carried still further by the force of the wind; besides, the loose ends of the wire, in a state of combustion, and driven by the same causes, would describe large curves and carry fire to great distances. As precautionary measures, therefore, the committee recommend—1st, The use of subterranean wires for that portion of any line that passes at a distance less than 100 metres from a magazine. 2nd, to lay the subterranean pipes for the wires at such a distance that there shall be no danger from the employment of the workmen either in laying the line or in repairing it. 3rd, To fix one or more lightning-conductors on poles 15 to 20 metres high in the neighbourhood of the same pipes, so as to protect them throughout their whole length against any direct action of the lightning.

THE RAPID EXTENSION OF THE ELECTRIC TELEGRAPH, as a means of inter-communication, is evinced by the various alterations and additions now being made in the metropolis, to meet the almost daily increase of business at the several stations, both of companies and the government establishments:

THE LONDON ELECTRIC COMPANY have erected new City offices, situated between Lothbury and Moorgate street. The instrument room is 70 ft. long, 30 ft. wide, and 26 ft. high. It is lighted from the roof; and in the operations performed in it, nearly 300 females will be employed. The light is so arranged that it will be all on the northern side, to avoid the rays of the sun, which, it appears, are prejudicial to telegraph manipulation. In the basement, the batteries and other apparatus, together with a powerful steam-engine (for the purpose of working the pneumatic pipes), will be fixed.

AT THE INDIA HOUSE NEW TELEGRAPH DEPARTMENT a number of workmen are engaged in converting the large room, hitherto used for the meetings of the court of proprietors, into suitable offices and rooms, in connexion with the new railway and telegraph department. The offices at the India house are already connected with the government offices at the west end by telegraphic wires. The new department will contain complete plans and sections of all the public works (relating to railways and telegraphs) already in hand, or proposed for construction in India.

DOVER AND CALAIS.—The Submarine Telegraph Company publicly announced (11th November ult.), the fact of direct communication between London and Paris (temporarily suspended by a defect in the cable) being re-established. The damage to the cable is understood to have been caused through a vessel dragging its anchor.

CONTINENTAL TELEGRAPH [EXTENSION] SYSTEM.—Posts have been erected between Norwich and Weyburn, and are now being carried on between Norwich and London, for connecting some of the Submarine Telegraph Company's continental lines with the metropolis. The existing telegraphic communication between Norwich and London is *viâ* the Eastern Counties Railway, and is worked by the Electric and International Company; but it is understood that a new and independent route is now being carried out by the Submarine Company, which has lately submerged two lines to Hanover and Holland, from the Norfolk and Suffolk coast.

MARINE STEAM ENGINEERING, SHIPBUILDING, &c.

THE "ORIENT" STEAM TUG, which left Gibraltar "tight, and in good order," early in October, ult., for the Bosphorus, has foundered at sea. On the 7th October she suddenly sprung a leak; all pumps set to work, but the water gradually gained on them. Put her head for Malaga, and commenced baling and clearing the deck of the coals, but all to no effect. Crew took to the boat, and had scarcely got clear when she went down head foremost, at about 4 30 a.m.

THE VILLAFRANCA [RUSSIAN] STEAMER DEPÔT.—According to the *Couriere Mercantile* of Genoa, the "Odessa Company" [*i.e.*, the Russian Government] is displaying the greatest activity in turning the Villafranca establishment to account. The directors of the works had already (middle of October, ult.) arrived; the necessary stores and supplies had been ordered at Toulon, and upwards of 200,000 metres of timber had been bought for the buildings to be erected. The steam-engines are to be sent from England. On the 18th November ult., a telegram, received in Paris from Nice, announced that two Russian vessels of war had, on the preceding day, taken possession of the establishment at Villafranca, ceded by the Sardinian government. Russian sentinels immediately replaced those of Sardinia.

THE TEHUANTEPEC STEAM AND TRANSIT ROUTE from the Atlantic to the Pacific is expected to be open in a few weeks. The first steamer was to start on the 27th October, ult., from New Orleans. This route is through Mexico, and is the most northern of all the passages over the American isthmus. The stage road of the Tehuantepec is 80 miles; the rest of the distance will be performed in river steamers. This route will cut off 1,400 miles in going from New York to San Francisco or British Columbia, instead of going by the Nicaraguan Lakes.

The "DUKE OF WELLINGTON," 131, screw three-decker, was, 25th October ult., taken out of Portsmouth Harbour, to try her engines, &c.; after proving their working, the staff of the steam reserve returned with her to harbour, and moored.

QUICK RUN TO ALEXANDRIA.—The screw-steamer *Malta*, belonging to the Peninsular and Oriental Company's fleet, has made the quickest run out to Alexandria (with the mail) on record, having accomplished the voyage in 10 days 13 hours, including 19 hours stoppages, being under 10 days in actual steaming. On her homeward passage she steamed from Alexandria to Malta in only 6 days 7 hours, inclusive of 8 hours' stay at Malta, and without any assistance from her sails.

FATAL COLLISION WITH A STEAMER ON THE BOSPHORUS.—Ali Ghalib, son of Reschid Pasha, and son-in-law of the Sultan, has been drowned in the Bosphorus. The barge on board which he was having come into collision with a steamer and been dashed to pieces.

THE "HIMALAYA" STEAM TROOP-SHIP was inspected on the 25th October ult., at Portsmouth, alongside the dockyard, by Admiral Sir George Seymour, &c., and passed a first-class muster. She is pronounced to be the most perfect troop-ship now afloat.

DEMARARA.—By late advices, to the 9th October ult., the new Colonial Contract Steamer *Essequibo* had commenced running, and her performances gave great satisfaction. Her first trip was to Essequibo and Berbice.

STEAM TUGS FOR INDIA.—On the 25th of October ult., several steam-tugs, built by Messrs. Blyth, of Limehouse, for service on the Indian rivers, to tow trains of craft carrying troops and stores, were ordered to be immediately shipped to Coringa and Madras.

THE SPANISH STEAMER FLEET.—The Spanish Navy has five steam frigates more than last year, and is being augmented as fast as the state of the finances will admit. It now (November, 1858), consists of four screw steam frigates, one of 50 guns and 390 H.P., one of 35 guns and 360 H.P., two of 31 guns and 360 H.P. each; nine screw steamers of 1 gun and 80 H.P. each; three paddle steamers, two of 16 guns and one of 10 guns, and of 500 H.P. each; twenty-six sloops of 6 guns and of different power; in all, forty-two steamers of 292 guns and 8,910 H.P.

NEW SPANISH LINE OF STEAMERS between Santander, Bilboa and London. The Spanish journals states that it has been resolved to establish regular lines of steam navigation between these ports; also to cause the mail steamer, between Alicante and Marseilles to make two voyages a-week instead of one.

THE "SCREW."—The "Austrian Gazette," in a recent article on the competition of foreign shipping with the Lloyd's of Trieste, makes the following doleful admission:—"At present" (October, 1858), "Austria has not a single screw vessel." . . . "Our sailing vessels suffer more than ever from the competition of screw steamers, which now appear, under the French, Russian or Greek flag, in waters in which the Austrian flag was most frequently seen."

THE "MELPOMENE" NEW SCREW FRIGATE, 600 horse-power (engines by Penn & Son), was taken out of Portsmouth harbour on the 29th October ult. by the staff of the steam reserve, to make a trial of her speed at the measured knot in Stokes Bay. The average of six runs gave a mean speed of 12½ knots per hour. Engines made 39½ revolutions (mean) with 20 lb. steam, and a vacuum of 26; diameter of cylinders 73 in.; stroke 3 ft. 6 in.; diameter of screw 18 ft.; pitch 25 ft. 6 in.; mean draught of water of ship 19 ft. Trial satisfactory.

FROM JULY 1ST TO OCTOBER 1ST, 1857, the number of vessels lost, bound to and from the United States' ports, was 445; and the total value 14,758,300 dollars. For the same period this year the number of vessels lost was only 229, and the total value 6,848,391 dollars, which includes the ill-fated *Austria*, valued at 800,000 dollars.

THE NEW SCREW STEAMSHIP "HERO," 91 guns, at Sheerness, proceeded, 6th November ult., on a final trial of her machinery, preparatory to the Admiralty authorities receiving it from the contractors, Messrs. Maudslay, Sons, and Field. Her mean speed was 11·75 knots per hour; mean number of revolutions 65 per minute; vacuum 26; steam-pressure 19 lb. per square inch. Draught, forward 16 ft. 3 in., aft. 21 ft. Temperature in her engine-room and stoke-hole, reduced considerably in consequence of the funnels fitted under the direction of Mr. George Blaxland, the stoke-hole being only 65 degrees, and the engine-room only 58 degrees on the average, although twenty fires were being constantly fed by the stokers.

STEAMER LAUNCHES.—From Woolwich Dockyard, the *Edgar* line-of-battle ship, first-class ornamental vessel, 91 guns, 600 H.P.; her guns disposed as follows:—on the upper deck 1 68-pounder pivot gun, 95 cwt., and 10 ft. long; 22 32-pounders, 45 cwt., 8 ft. 6 in. guns. On main deck 34 32-pounders, 58 cwt., 9 ft. 6 in. guns; on lower deck 34 8-pounders, 45 cwt., 9 ft. guns. Burthen in tons 3094; crew 860. Dimensions—

	ft.	in.
Length between perpendiculars	234	3
Length of keel for tonnage	195	3
Breadth (extreme)	55	5
Do. for tonnage	54	7
Do. moulded	53	9
Depth in hold	24	6

Soon after the launch she was towed down to Sheerness to be "coppered" and receive her crew, machinery, boilers, guns, and other gear.

LAUNCH OF THE "PARAMATTA."—The first of two iron ships, of very large dimensions, built by the Thames Iron Company for the Royal Mail Steam Packet Company, to replace their wooden vessels *Magdalena* and *Orinoco*, took place 8th November ult. The *Paramatta* is a magnificent vessel of upwards of 3,000 tons, from the drawings of Mr. Rennie, naval architect to the Company. Length between perpendiculars 330 ft. extreme breadth 43 ft. 9 in., exact burthen 3,092 tons, superficial space allotted to passengers in the main and saloon decks 270 ft. Barque-rigged, paddle-wheeled, to be fitted with engines of 800 H.P. by Messrs. Maudslay and Field, to be transferred from the *Orinoco*. To be ventilated on the plan known as Robinson's patent.

A COLLISION (IN THE CHANNEL) between two steamships, occurred 9th November ult. The screw steamer *Cataluna* came into collision with the freight-ship *Melbourne*, off the Star light. The *Cataluna* is of 1,500 tons, and 300 H.P., trading under the Spanish flag, bound, on the present occasion, from Barcelona to Southampton with a full cargo. The two ships ran stem on each other. The *Cataluna* carried away her bowsprit and cut-water; injury done to the *Melbourne* not yet ascertained, as the two ships quickly separated each following its own course. The *Cataluna* has gone into Southampton Docks for repairs. No lives lost on board the Spanish ship. Cause of accident unknown.

THE RUSSIAN STEAM NAVIGATION COMPANY have recently received some modifications in their statutes, the principal of which is that their steamers, which, hitherto, have not quitted the Mediterranean and the Black Sea, shall be allowed to go to the ports of England and Belgium.

A NEW DESCRIPTION OF SCREW-PROPELLER, the invention of Mr. Phillips, C.E., has been ordered to be tried at Portsmouth, in the *Bulfinch* gun-boat. The blades are curved inwards, which the patentee imagines will do away with the "broken water," in which case there will be great power gained and less slip.

THE "VULCAN" IRON STEAM TROOP-SHIP, in No. 9 dock at Portsmouth, is ordered to be fitted with new engines of 400 H.P. by Maudslay.

THE "URGENT" 6, Iron Steam Troop-ship, recently grounded off Chichester. On the water leaving the dock in which she was subsequently placed at Portsmouth, an examination of her bottom exhibited no signs of any damage having been done her by the accident. She has, consequently, been ordered to again prepare for the embarkation of troops in a few days. The officers in charge are to be tried by court martial on board the *Victory* flag-ship at Portsmouth.

THE "ROYAL SOVEREIGN" 131, new screw 3-decker, and the *Algiers* 91, screw 2-decker, at Portsmouth, are having their engines disconnected.

THE "NEPTUNE" 120, old sailing 3-decker, at Portsmouth dock-yard, is being converted into a 90-gun screw line-of-battle ship. Upwards of 400 hands were, 1st November ult., by order of the Admiralty, put on her to complete the alterations with all speed.

WAR STEAMERS NOW IN HAND AT PORTSMOUTH.—The dock-yard authorities have as many men employed as can work on the following steam ships, with the object of getting them out of hand with all despatch. The *Victoria*, 121 guns, 1,000 H.P.; the *Prince of Wales*, 131 guns, 800 H.P. (both on the stocks); the *Neptune*, 120 guns, sailing ship, under conversion to a 91 gun screw 2-decker, with 600 H.P.

LOSS, BY FIRE, OF THE STEAMER "HUDSON."—In the night of the 3d November ult., this splendid new steamer caught fire at her moorings in Bremenhaven, at the mouth of the Weser, and was burned to the water's edge. She is a total loss; no lives lost. She belonged to the North German Lloyd's Company of Bremen; was American built, and had only just taken her place in the line of steamers which leave Bremen and New York every fortnight. She was 350ft. long, and 40ft. wide, with direct-action engines capable of being worked up to 2500-horse power; cylinders 6in. larger than those of the *Great Eastern*.

THE "ORLANDO" NEW SCREW STEAM-FRIGATE, 50, in Keyham-yard, Devonport, is being brought forward for immediate trial, to be then placed in second-class steam-reserve. Engines (Penn and Son) 1,000-horse power (the largest in the navy); cylinders 100in. in diameter, stroke 4ft., screw 20ft. diameter, pitch 32ft. 6in. At her trial at moorings she made 45 revolutions, with pressure of 13lbs. per square inch (the utmost power allowed at moorings). Expected to make 14 knots by steam only.

THE "ABOUKIR," 90, got up steam, in Hamoaze (13th November ult.), for her trial outside Plymouth Sound. A mean of 9½ knots obtained against wind and weather. Engines by Penn and Son; mean revolutions, 63¾; steam, 20lb.; vacuum, 26; pitch of screw, 17ft. 6in.; nominal power of engines, 400-horse, worked up to about 600-horse; in second-class steam-reserve.

MILITARY ENGINEERING, &c.

PERCUSSION-CAPS, BY AUTOMATIC MACHINERY.—Woolwich is now not only an immense magazine for all the munitions of war, but it is the largest manufactory in the world. In its huge workshops are accumulated almost every known variety of ingenious mechanical contrivance for saving labour, and dispensing with manual dexterity. Take, for instance, the machine, still there, for making caps, which used to cut the copper from the sheet, stamp it to fit the gun's nipple, charge it with detonating-powder, and turn it out ready for use. By its side is another, which, somewhat more simplified and restricted in its operative details, works, for the same results, with still greater speed and precision.

RIFLE-BALLS, SHOT, SHELLS, ROCKETS, &C.—The processes connected with the manufacture of these items of war material, as conducted at the Royal Arsenal, Woolwich, are of surpassing interest. The lead for Minié bullets is formed into rods, which are coiled round a wheel on the machine. This lead is prepared by forcing it, in a semi-fluid state, through a hole in a cylinder. There are eight double Minié bullet machines, which can turn out 480 balls a minute. The diameter of these balls is now being reduced from ·568in. to ·55in., a dimension which, whilst equally effective, is expected to foul the piece less. In the "Cartridge-room" there are between 400 and 500 boys. These lads are paid 1½d. per hundred cartridges; and some of them are known to make up as many as 2,000 per day. There is, however, a scheme now in operation for dispensing with a great deal of this boy-labour. A number of little canvas bags are plunged into a trough containing pulp; the air is then drawn from the inside of these bags, and they are instantly coated with paper. These latter are taken off and dried, and the cartridge case is complete.

THE GUN-CARRIAGE DEPARTMENT every week completes a battery, consisting of 6 guns and 24 carriages, with all their appointments. It also turns out 10 traversing gun platforms for the coast, 2,000 shot and shell cases, and 200 powder cases. There are 2,200 men employed in this department. The "carriage factory shed" covers 4 acres, and is capable of receiving 5,000 loads of timber. Here, the timber intended for the traversing-platforms of large guns, &c., is kept seasoning for years, the very best and soundest wood alone being suitable for the work. One species of steam saw which performs a great rôle at Woolwich, is a toothed steel-band, which is passed over two rollers, like an endless strap. This was brought from the Paris Exhibition by Colonel Tulloch; subsequently improved upon, it is now used for every purpose for which a carpenter's dissecting-saw would, formerly, have been employed. The felloes of each wheel, after being cut out with this implement, are put together and turned, so as to make a perfect circle. The nave is also turned and pierced for the spokes by machinery. The spokes themselves are shaped by an ingenious contrivance, by which cutters are made to reduce a straight piece of wood into an exact fac-simile of a cast iron model. The parts of the wheel are then fitted together, and placed in a pressing machine, where, by the force exerted by 6 hydraulic rams, the whole is firmly compacted, and made ready for the tire. The "pressing-machine" does in two or three minutes what would take a wheelwright at least three-quarters of an hour; whilst the band saw will cut one particular portion of the work in 30 seconds, which could not be done by hand in less than 15 minutes; thus realising a saving of time in the ratio of 1 to 30, with this further advantage, arising from the employment of machinery, that every like portion of every article being exactly of the same size, no difficulty is experienced in making the parts fit, or in supplying any faulty part when on service.

SUBMARINE BLASTING.—The removal, by blasting, of a portion of the rock which forms a ridge across from Devil's Point to Mount Edgecumbe (Plymouth), took place on the 28th of October last, under the direction of Captain Jernyngham, R.N. The blast took place at 11 o'clock. About 10 o'clock the diver went down to connect the wires to the canisters containing about 200 lbs. of powder, which took him about half an hour, when he returned to the boat. The sounding of bugles from the boat and the shore was a signal that the battery was charged, and in about ten minutes there came a dull heavy sound, then a shock which was plainly felt, and a mass of water and stone ascended in the air to a height of from 40 to 50 ft. A few minutes after the shock, the spot where the blast had taken place was like a mill-pond, although the wind was very high. The operation was quite successful.

FLOATING BATTERIES.—The question of the use of iron plates for the protection of floating batteries is not entirely new. It is now some years since the covering of the exterior of batteries and vessels of war was proposed by Colonel (now General) Paixhans of the French artillery, Metz. This he did in a work entitled, "Nouvelle Force Maritime," in which he stated that to enable a vessel so plated to resist a 32 lb. shot, it required a thickness of several inches. Subsequently, at the commencement of the late Russian war, vessels of great burthen and strength were constructed and covered with massive wrought-iron plates of from 4 to 5 in. in thickness, both in France and England. These iron-plated batteries, however, have not been brought into much practical use, and their efficiency has of late been more than questioned.

PLATES AS A SHOT-PROOF DEFENCE.—The results of a series of experiments made some years since, by the United States Government Artillery corps, on the effect of shot fired at a target covered with iron plates (set at different angles) by a 32 lb. gun of 56 cwt., and with charges of from 4 lb. to 10 lb. of powder, are shown by the following table:—

Angle of Plate. degrees.	Charge. lb.	Shot broke.	Deflection of Fragments. degrees.
10	10	do.	4½
12	10	do.	17½
15	10	do.	13
17	10	do.	30
20	10	do.	21
22	10	do.	18½
25	4	do.	21½
27	10	do. in four pieces.	11½

SHOT PROOF PLATES FOR SHIPS OF WAR.—A plan has been recently submitted, by Mr. Bruce Neil, to the Lords Commissioners of the Admiralty, and to the Commander-in-Chief of Portsmouth Dockyard, for covering the iron plates encasing ships of war with a padding or buffer of compressed cork, to the depth of several inches glued on patent felt, or thick leather, and then attached to the outside of the iron plates. From the yielding and highly elastic nature of the compressed cork, the inventor states that, on striking, the balls will rebound, and, by thus breaking their force, will not injure the iron plates. The cork also possesses another feature which is said to be an additional recommendation, viz.: that if struck by red hot shot, it is very slow to burn. A similar padding or buffer can be placed between the iron plates and the wooden plates of the ship. One portion of this proposal forces irresistibly on our mind the reminiscence of the old joke—"nothing like leather."

NEW BREECH LOADING CANNON.—Experiments have recently been made at Chatham to test the merits of a new cannon of this class, the invention of armourer-serjeant Warry. Although the model is only four in. long from the breach, the gun did execution at 100 yds., and out of the 100 rounds fired not one missed. Subsequently, 50 rounds were fired in only five minutes, the gun being loaded and fired at the rate of 10 rounds per minute, the shots taking effect at 50 yds. The invention is stated to be highly approved of by the officers before whom it has been tried, and a favourable report of it will be made to the authorities at the War Office. It is added that, by this principle, large vessels of war can be made to fire 10 rounds per minute.

STEAM FLOATING BATTERIES—RIFLED CANNON.—The gun-boat *Stork*, tender to the gunnery ship *Excellent*, was engaged at Portsmouth, 25th October ult., in firing at the iron-built steam floating battery *Erebus*, moored within point blank range. The weather was very thick, but the shot appeared to enter, if they did not go through the iron battery. The *Erebus*, we may remark, is the most recently constructed, and hitherto considered to be the best of the "floating batteries" constructed to steam close under an enemy's forts; they were supposed to be bomb proof, the outside shell of the battery consisting of iron plates four in. in thickness. The range of the *Stork's* guns was between 200 and 300 yds.; the new "rifled cannon" were used on this occasion, and the result (subsequently announced) was, that the shots penetrated her (the *Erebus's*) side, thus proving that these "batteries" will be perfectly useless for the purpose for which they were intended.

SCHRAPNELL SHELLS.—As an illustration of the changes that have taken place within the last few years in the manufacture of munitions of war, chiefly in consequence of the introduction of powerful machinery in the Royal Arsenals (as at Woolwich, for instance), joined to the modern system of the minute subdivision of labour, it may be mentioned, that the government contract price paid, at the commencement of the late Russian war, for Captain Boxer's six-pounder diaphragm schrapnell shell was £73 per cwt., whereas the same article can now be actually made for £14 9s. 2d. per cwt.

WOOD OR IRON FOR SHOT PROOF-PLATES.—The *Meteor* 14 gun steam battery, 150 H. P. was taken up (4th November ult.) from Portsmouth Dockyard, and moored in Porchester Lake, in the line of fire from H. M. ship *Excellent*, one of whose gun-boat tenders will commence firing at her forthwith to test the difference of the effects produced by solid shot upon an iron battery, lined with wood, and one built of iron entirely, as the *Erebus*.

IRON-SIDED FLOATING BATTERIES.—The vulnerability of these much talked-of constructions has again been demonstrated. The gun-boat *Snapper*, attached to the *Excellent*, resumed her experimental practice (at Portsmouth), on the side of the *Meteor*, 8th November ult., in presence of Admiral Sir George Seymour, and other officers of the port. The portion marked for the target was over the sixth and seventh port from the bows, about 12 feet in length, and extending from the bulwarks to the water line. One 32 lb. and four 68 lb. shots were fired. The former did no material damage, but one of the heavy shots with a minimum charge of powder passed through the side of the battery, making a hole sufficiently large for the admission of a man's body.

ROYAL ARTILLERY AND GUN-FACTORY DEPARTMENT OF WOOLWICH ARSENAL.—The recent inquiry, by Royal Commission, into the state of the principal military depôts, &c., at Woolwich, has elicited much useful information. From the evidence of Lieutenant-Colonel Wilmot of the Royal Artillery, and Colonel Superintendent of the Royal Gun-Factory, it appears, that of new buildings there are the Iron-gun factory and Boring-mill, the Shot and Shell foundry, the Rocket manufactory, the Paper-cartridge factory, the Gas-works, new Storehouses, the enclosure with a boundary wall of about 140 additional acre of land, besides alterations in the gun-factories, carriage-department, and laboratory, almost amounting to an entire renovation. The 10-hours system of working hours has been introduced, as also the closing at mid-day on Saturdays, and the application of piece-work. Number of men now employed in the gun-factory, upwards of 800; formerly, on the old system, there were only about 90. The Gun-factory was commenced on its present footing on the 1st of April last; and the understanding is that they are to make 150 guns in it during the present year. Only half the intended number of furnaces for making guns are at present complete; if in full activity, it might turn out 600 or 700 guns a-year. Supplies guns for the navy as well as for the army. Actual cost of labour expended on each gun made in the factory, in boring, turning, moulding, &c., not including material, about £13. Contract-price of a similar gun (including material) would be about £100. Cost of the new establishment, as shown by a Parliamentary Return, about £120,000; but in that, the value of a large quantity of iron was included by mistake. In the LABORATORY. there are about 3,000 men and boys employed. It turns out weekly 1,500,000 cartridges for small arms, a number which can at any time be increased to 2,000,000 a-week. At present fabricating 30,000 shot and shell a-week, and could do 40,000 weekly, by working overtime. On one occasion, during the latter part of the war, they fitted out 10,000 of the largest description of shells, with fusees, in 24 hours. The work in this department is going on with great activity at this moment (9th November, 1858). By the new arrangement, the head of each department has the charge of all the raw material used in his particular branch.

BRASS GUNS.—Seven 9-pounder brass-guns, cast at the Foundry in Woolwich Arsenal, were (November 17th ult.) proved at the butt; six of which were found defective, and were ordered to be returned to the Foundry to be re-cast.

FRENCH BATTERIES, &c.—General de Preuilly, Inspector-general of Marine Artillery, has been commissioned to make a special inspection of the Batteries on the coast of France.

PERSIA, it seems, is not unmindful of the improvement of her Navy. Advices from Paris, of the 19th November ult., announce that "a Naval Engineer is to be authorized to take service in Persia." His engagement is to be for five years.

HYDRAULIC ENGINEERING, &c.

PUMPING-ENGINES for the new Drainage.—The prospects of this branch of engineering business are somewhat promising. The Main Drainage Committee, in their recent Report to the Metropolitan Board of Works (*inter alia*) state that they have considered the preliminary steps for erecting the Pumping-engines required for the Main-drainage, and recommend to the Board to invite tenders from not more than 20, or less than 12, of the principal manufacturers for designing and constructing pumps, engines, &c. to be erected within the Metropolitan District, capable of lifting, continuously, the requisite amount of sewage water.

A WATER-LIFT STEAM-PUMP, constructed by Messrs. Carrett, Marshall, and Company, of Leeds, is now working in Holland; it will raise 6,685 gallons 10 feet high per minute. The steam-cylinder is 25in. diameter, and the pump 5ft. diameter. In this arrangement, chiefly adapted for drainage purposes, the water to be raised is not enclosed in pipes, and there is no rotative or fly-wheel medium employed.

STEAM FIRE ENGINE FOR THE RUSSIAN GOVERNMENT.—On the 22nd October ult. trial was made at the Grand Surry-canal, Camberwell, in the presence of Mr. Braidwood, superintendent of the London Fire Brigade, and of several scientific gentlemen, of Messrs. Shand and Mason's newly patented fire engine, to be worked by steam. The engine was only completed on the day preceding, and, on account of the close of the St. Petersburgh shipping season, was, during the afternoon, put on board a steamer for that port. In ten minutes from lighting the fire, sufficient steam was obtained to throw a 5-8 jet of water to a considerable elevation. This was changed for larger ones up to 1 in. in diameter, the height from the latter being equal to that from a brigade-engine when worked at its greatest speed. Two jets, one being 7-8th of an inch, and the other a 16th smaller, were used at one time, and projected the water to the same height. The space occupied is the same as by one ordinary brigade-engine; but it is stated to be equal to three in power, as worked in the usual manner by 28 men, so that an equivalent to the labour of 84 men is obtained. It is worked with great steadiness, very little noise or vibration being perceptible. The engine is fitted with springs and high wheels for quick travelling. The boiler, fitted with perpendicular brass tubes, is placed in the centre of the hind-axle; the steam and fire engines being placed over the front axle. The hose and suction pipes, with the implements, have their places in or about the engine, so that all are carried with it.

WATER SUPPLY—(METROPOLITAN AND PROVINCIAL).

LIVERPOOL STREET FOUNTAINS.—Statistical observations taken on this subject, as regards Liverpool, show that, on the 9th of April 1855, 2,308 persons were counted drinking at the Princes Dock Granite Fountain, in 12 hours; on the 22nd June, same year, 3,340 persons drank at the Iron Fountain, George's Dockbridge, in 12¼ hours, making an average of more than four persons drinking every minute throughout the day.

AT LEEDS, the Corporation have erected six drinking fountains at their own expense.

AT HULL, Mr. Henry T. Atkinson has placed three, and soon after the water had been turned on to the first one, 3,124 persons availed themselves of it in one day.

AT ST. HELEN'S, 800 to 1,000 persons drink every day at an Iron Standard Fountain, erected by Mr. Charles Bishop.

AT DERBY, one of the small Granite Founts has been placed by the Rev. J. Erskine Clarke in the abutment of St. Michael's church.

A PUBLIC DRINKING FOUNTAIN, the gift of S. Gurney, Esq., Lombard street, is to be placed on Holborn hill; the vestry meeting of the parish of St. Andrew, Holborn, having, 9th November ult., unanimously accepted the donor's philanthropic offer to erect one at his own cost, the rector and churchwardens being requested to fix the site.

MADRID.—The works which are being carried on, in order that this city may enjoy an abundant supply of potable water, are in a state of great forwardness, the labours being gone on with night and day.

THE NEW FOUNTAIN AT HOLYROOD is in progress. Workmen have commenced inclosing the area. The design is taken from the fountain which formerly stood in the grounds of Linlithgow-palace. It is to be an octagon, surrounded by a basin of 25 ft. in diameter, from which it will rise to a height of 35 ft. Elevation divided into three tiers, surrounded by various quaint figures. To cost £1,400.

ST. PETERSBURGH.—The "Gazette of the Senate," of the 10th November ult., contains the regulations of a company recently established for the purpose of supplying St. Petersburgh with water. The capital is 1,200,000 silver roubles; and the local municipality guarantees 4½ per cent.

GLOUCESTER.—The first sod of the reservoirs at Witcomb has been turned by the Mayor. This completes the system of water-supply (long since needed) adopted for this city. The gathering ground will exceed 1,000 acres—depth of the water, in some places, 40ft. Reservoirs estimated to contain a sufficient supply, for six months, for a population of 30,000 persons. To cost for reservoirs £14,205. 13s. 2d. Cast iron pipes £469. 6s. 6d. Ditto sluice-cocks and valves £180. 15s.

GAS ENGINEERING—(HOME AND FOREIGN).

THE DOME OF ST. PAUL'S has been lighted with gas. On the evening of the 3rd November ult. the trial of effect took place, privately, but with complete success. The light shed from 1,500 burners, surrounding the cornice of the dome, produced a radiance sufficient, not only to illuminate the entire area, disclosing the magnificent proportions of the structure, its splendid paintings, &c., but also enabling persons with eyesight of ordinary strength to read the medium-sized print of the book of Common Prayer.

SUFFOCATION BY GAS (AT NEWPORT).—The fifth victim (the wife) in this sad affair expired on the 6th November ult. At the inquest, held on the 8th, similar evidence to that previously given as to the husband and children was produced, and a verdict was returned that the deceased (aged 35) "died from the effects of inhaling carburetted hydrogen gas."

COST OF STREET-LIGHTING BY GAS.—Reports on this subject (founded on scientific experiments, &c.) have recently been issued by authority of the Westminster District Board of Works, and from one of them (that of Mr. Hughes, connected with the Metropolis Gas Inquiry) it appears that "the total amount of actual imposition on the district by the three companies supplying it (viz. the Chartered, the Equitable, and the Western) is £2,012 6s. 1d. per annum, the lion's share of which (£1,750 13s. 4d., or 832 lamps) is that of the Chartered Company. As regards quantity, each company is bound to supply light equal to ten spermaceti candles, burning 120 grains per hour, from sunset to sunrise, or twelve hours daily on the average. In these respects great deficiencies are complained of, the "Chartered" lamps in no instance having had a supply at 12 p.m. of more than 1¾ cubic ft. (instead of 2½ cubic ft. of cannel coal-gas) per hour; so that the rate at which the last-named company are charging for the supply actually given is no less than 10s. 2d. per 1,000 cubic ft. The other companies also, are, by this report, stated to be charging in excess of the price to private consumers.

GAS-METER FOR ST. PAUL'S.—A gas-meter has just been fixed in St. Paul's Cathedral, in order to register the gas supplied for the illumination of the dome-area from above, during the evening services. The meter is nearly 22 ft. in circumference, and will pass 6,000 cubic ft. of gas per hour. The corona of the dome is already fitted with pipes, having several thousand projecting nipples, from which jets of flame will issue.

AN EXPLOSION OF GAS took place, 1st November ult., in a public house at Rosehill, Liverpool. In the morning the proprietor was roused by a strong smell of gas, which appeared to come from the sitting-room. On opening the door he was nearly suffocated, and he took the precaution of opening the window. He then lighted a match before he had given the gas time to escape, with the object of finding out the leakage, when, with a loud explosion, the whole room became filled with flame, and the house was nearly shattered to ruins. Feeling nearly suffocated, he first tried the door; but it had closed with the shock; he then jumped out of the window, and was picked up in the street with his clothes on fire. He is hardly expected to recover.

A "PATENT SAFETY ATLAS SLIDING-CHANDELIER," on the telescopic principle, in connection with gas-tubes, has been produced at the Atlas Works, Hatton Garden. Its object is to prevent explosions of gas in private houses, &c. It can be adjusted at any distance from the ceiling; and its principal recommendations are said to be facility of adjustment, prevention of any escape by the straining of the tubes, and the avoidance of danger from the breaking of the chains which form the chief support of the telescopic apparatus.

HARBOURS, DOCKS, CANALS, &c.

THE SUEZ CANAL.—At Marseilles, 27th October ult., at the banquet given to M. Lesseps, that gentleman stated, in reply to a toast, "that the works of the Suez Canal will commence in three months, and that the Canal shall be opened in three years."

SUNDERLAND DOCK COMPANY AND RIVER WEAR COMMISSION.—Steps are being taken to amalgamate these bodies, and it is stated, from Newcastle-on-Tyne, that the Dock Company have made a proposal to dispose of the Docks to the Commissioners, that the offer has been accepted, and an application is to be made to Parliament to sanction the arrangement.

GLOUCESTER AND BERKELEY CANAL.—The receipts of this canal for the past half-year have exceeded by £2000 those of the first half-year of 1857, notwithstanding the admitted decline in the timber trade consequent on the competition offered by the railway system of the midland district.

LIGHT-HOUSES IN THE MEDITERRANEAN.—Progress is making in the Cane Rock Lighthouse which is to guide vessels up and down the Mediterranean, and especially when bound for Tunis. Others are likewise spoken of as wanted—one, for instance, on the Island of Galeta, to keep vessels off the Torelli rocks, whereon ships bound for Malta are often driven by the current; another on Cape Trafalgar or Spartel.

STEAM-TUGS FOR HORSES.—Recent experiments on the Aire and Calder navigation have shown that, by the use of Steam-tugs for the conveyance of minerals, the cost of locomotive power has been reduced to between 1-10th and 1-12th of a penny per ton per mile, the usual cost of H. P. being 1-8th of a penny. Mr. Liddell has recently proposed a new mode of propulsion on canals, viz.—by means of fixed steam engines and endless wire ropes.

THE MERSEY DOCK BOARD have resolved to expend £300,000 for additional accommodation at the north end of the Dock-range for the steam, timber, and carrying trades.

NEW (PROPOSED) DOCKS AT BURNHAM, on the Somersetshire coast, opposite Cardiff, are in serious contemplation. Vessels can run from one place to the other in a single tide, and so save the railway transit from Bristol to Burnham.

THE NEW LIGHTHOUSE at the entrance of Port Jackson (Australia), is being finished. It stands on the edge of the Cliff forming the inner South Sea Head at an elevation of 60 ft. above sea level.

KINGSTOWN PIER.—The Dublin papers teem with complaints against the exposed state of the landing-place at Kingstown, and it is proposed to construct a tramway from the Pier to the Railway, and to cover in a portion of the jetty.

THE WEXFORD EMBANKMENT COMPANY are about laying out £4,600 in the reclamation of slob-wastes.

DOCKYARD ECONOMY.—The Committee of Investigation, consisting of Rear-Admiral R. Smart, K.H., Mr. R. Laws, &c., are still actively engaged in their examinations of the system pursued at this dockyard, more especially as regards the ropery, smithy, metal-mills, and factories.

DEVONPORT HARBOUR.—The operation of blasting the VANGUARD ROCK, at the entrance to this harbour, has been effectually carried out, after several unsuccessful attempts. This rock has long been a most dangerous obstacle to navigation. Captain Jerningham, of H.M.S. *Cambridge*, superintended the work. On the 5th November ult., 13 minutes after the fuse (on the old method, not the electric) was ignited, the cylinder exploded, carrying up a cone of water, estimated at 100 feet in diameter, at the base, and about 40 feet high. The effect on the surrounding mass of water, for some two or more miles in circumference, is described as being very great, and a large quantity of sea-weed and sand was thrown up. Extent of displacement not yet ascertained. A tremor resembling that produced by an earthquake was felt along the shore of the harbour. Thousands of fish were (it is stated) seen to jump out at the time of the explosion; and, in the immediate vicinity of the operations, many came up to the surface of the water, killed by the shock.

NEW (PROPOSED) DOCKS AT FULHAM.—Amongst the other objects contemplated by the West London Railway Company, in their application to Parliament, is the construction of a Dock, &c., thus described in their official notice,—"A Railway, commencing by a junction with that extending to the Pimlico station, &c., at or near the lock or basin of the Imperial Gas Light and Coke Company, in the parish of Fulham, and terminating at the bank of the river Thames, about 30 chains above the mouth of the Kensington canal, together with a Dock or Basin, and all necessary locks, sluices, culverts, weirs, and other works and conveniences connected therewith, at the terminus of such railway."

BRIDGES.

IRON BRIDGES.—The forms of iron bridges which have been practically tested may be divided into five classes; viz., the arch, the suspension-bridge, the tubular-girder, the lattice-girder, and the bow-string girder, exemplified respectively by 1°; the New Westminster-bridge (engineer, Mr. Page), 2°; the Suspension-bridge at Chelsea (ditto), 3°; the enormous viaduct across the St. Lawrence, at Montreal (Stephenson) 4°; the Crumlin viaduct which crosses the vale of the Taff, at the height of 220 ft. and 5°. Mr. Brunel's gigantic viaduct at Saltash, in which the bow-string, in place of the usual straight tie, is made to take a curved or polygonal form, and to act as a suspension chain.

PIER BASES.—As recent examples of improved construction and inventive ingenuity on this head may be cited the bases of the piers of the New Westminster-bridge, consisting mainly of cast-iron boxes filled with concrete; those of the Victoria-bridge at Montreal, which are of massive granite masonry, intended to withstand the floating ice of the river; and the central pier of the Saltash viaduct founded (by a process originally practised at the New Rochester-bridge), by the sinking of vertical iron cylinders filled with compressed air, inside of which the excavators and masons work.

RIVER IRWELL.—The first stone of a new bridge over this river has been laid (as a private construction for the present, but eventually to be made public), by a landowner, in order to connect his extensive estates. The bridge will be of stone and iron; to consist of two arches of about 50 ft. span each, crossed by flat cast-iron girders. Stone piers 15 ft. wide. Roading 12 ft. clear. Will be constructed to carry 30 tons. Erection at sole cost of the proprietor, Mr. Fitzgerald, of Castle Irwell.

BOILER EXPLOSIONS.

THE BOILER OF THE STEAMER "WEASEL," tender, between the Canal-basin and the Samphier-roads to the Limerick and London Steam-ship Company's vessels, whilst towing a schooner from the Samphier up the Irish Channel, exploded on the 23rd of October ult. The vessel sunk about 3 ft., and shortly after went down entirely, carrying with it the fireman, supposed to be locked in the engine-room. The captain's son was blown into the water, with some others of the crew, but picked up by the schooner's people, several of whom were injured by the splinters of the *Weasel*. She was bought on the Clyde a short time since, and cost £1,200.

A FATAL BOILER EXPLOSION, connected with the heating apparatus belonging to the Independent Calvinist Chapel, Rycroft, Ashton-under-Lyne, took place in the afternoon of the 13th of November ult., resulting in the death of two women, and the scalding of several persons. The chapel is heated by hot water, the boiler and apparatus being fixed in the cellar. The neighbours, alarmed by a loud report, effected, with difficulty, an entrance into this cellar, the explosion having blown the entire apparatus, with the iron and stone-work, against the street-door leading to the small room. Two women (one the wife of the chapel-keeper), were removed from the *débris* behind the door, so fearfully scalded and otherwise injured, that they expired in less than two hours. The explosion is supposed to have been caused by a stoppage of the over-flow pipe, and the consequent generation of too much steam.

ACCIDENTS FROM MACHINERY.

CLEANING ENGINES.—On the 29th October ult., a stoker on board the *Citizen* steam-boat trading from London to Holland, whilst cleaning the engine, got his leg and foot in the machinery, crushing them in a frightful manner. He was conveyed to St. Thomas's hospital, and remains in a precarious state.

RAILWAY LINES.—On the same day, a watchman on the South Eastern Railway, was wheeling a barrow on the line near the Charlton Station, when he slipped down, a train from Plumstead was passing at the time, the wheels of which passed over his shoulder, crushing it in a frightful manner. Removed to St. Thomas's hospital, where amputation was deemed necessary. Recovery doubtful.

GRINDSTONE-FITTING.—The "Aberdeen Journal" records a recent fatal accident at the Devanha comb works, Aberdeen. The proprietor of the works was assisting his men to fit a grindstone and get it into working order; whilst he was engaged keeping the belt on the driving pulley, the stone, from the tightness, revolving with great rapidity, suddenly flew to pieces, in consequence, it is supposed, of some latent flaw; one of the pieces, about 1-4th size of the whole, struck the proprietor on the temple with such force that part of his skull was knocked in.

A CORN MILLER (John Mansergh Askew), of Kirkby Lonsdale mill, has been killed in his own machinery. On the afternoon of the 26th October ult., about ten minutes after he had started the mill, his wife, from the outside, observed it suddenly to stop. On the alarm being given by her the water was turned off and the body was found grasped between the fly-wheel and the jack-wheel, his arms hanging over the wheels, and the right shoulder and right side of his chest fixed in between the cogs of the two wheels. He was quite dead. It appears that the deceased was either greasing the spindle neck or going to do so, and that the wheels must have caught his clothes and dragged him in, or that his foot had slipped and he had fallen in between the wheels. No other person was in the mill when the accident happened.—Verdict, "Accidental death."

AN ENGINEER CRUSHED TO DEATH.—On the 20th November ult., the Admiralty yacht *Black Eagle* returned to Woolwich from Dover, with the body of the third engineer, named Alibone, to await the inquiry of a coroner's jury. On the previous Wednesday, two hours after sailing from Dover Roads, having embarked the Prince of Wales and suite for Ostend, the deceased was engaged in the engine-room, and was in the act of "feeling the crank for hot bearings," when, from a sudden lurch of the ship, his foot slipped, and falling forwards, his head was caught between the crank head and the beam, causing instant death.

MINES, METALLURGY, &c.

Mineral Statistics of the United Kingdom for 1857.—From these statistics, prepared and issued as mining records, from the Museum of Practical Geology, by order of the Lords of the Treasury, and just published, it appears that the produce of British tin was, in 1857, of tin ore 9,783 tons, producing of metallic tin 6,582 tons, being an increase of 433 tons of tin ore, and 465 tons of metallic tin as compared with 1856. Importations (in 1857) of metallic tin (in blocks and ingots) 2,708 tons, and of tin ore and regulus 1,387 tons; total 4,095, against (in 1856) blocks and ingots 3,464 tons; and of regulus 749 tons; total 4,213 tons, showing a decrease. Of the tin ore 816 tons were the produce of our colony Victoria.

Copper.—Our importations exhibit an increase, viz.:—

	Tons.		Tons.
1857, Copper ore	75,832	Regulus	19,262
1856, Copper ore	71,678	Regulus	11,124
Increase	4,154	Increase	8,138

Exports in 1857, Metallic Copper 25,241	Declared value	£2,815,831
„ 1856, Metallic Copper 22,863	Declared value	£2,648,259
Increase 2,378		£ 167,572

Lead and Silver.—The variations in the production of metallic lead and silver from British mines have been as follows:—

		Tons.		Ozs.
1855	Lead	65,529	Silver	561,906
1856	„	73,129	„	614,188
1857	„	69,266	„	532,866

The produce of British mines shows a decrease of 3,863 tons of lead, and of 81,322 ounces of silver. Our importations of lead exhibit also a falling off of about 3,000 tons; and of foreign silver ores, instead of 6,636 tons, the quantity brought into the country in 1856, we only imported 5,190 tons, being a decrease of 1,440 tons.

Iron.—Towards the close of 1857, about eighty blast-furnaces were extinguished, naturally leading to a belief that the falling off in pig-iron would have been very considerable. It is found, however, that we made of

Pig-iron in 1857	3,659,447 tons
Against do. in 1856	3,586,377 tons

This increase in the make of iron for the year, notwithstanding the depression of trade at the close, is explained by the fact that np to the crisis in October, enormous quantities were made in some works, and thrown upon the market at reduced prices, to endeavour to avoid the threatened pressure on our metallurgical industries.

Copper Mines of South Australia.—The principal copper-mine now being worked is that of the Burra Burra, which (as stated upon good authority) at the rate of 40 per cent. per annum to its original shareholders, the ore yielding, on an average, 22 to 24 per cent. of copper. The Kapunda, of which the working capital is only £6,000, it is said, produces at the rate of £25,000 per annum, and gives only 15 per cent. of copper from the ore. At Chamber's Mine, an entirely private enterprise, the average yield is reported equal to that of the Burra Burra. The Port Lincoln now lies inactive, from the apathy of the present owners of the land. Two more mines of great promise are now being opened up: one, the North Rhine of South Australia, gives on a produce of about 200 tons, an average yield of 27 to 30 per cent. of copper; and the other, the Bon Accord, although not yet returning, gives good indication of early yield.

New Gold Fields have been discovered at Port Curtis, north of Sydney. According to late advices (from Sydney to September 10th ult.) they are very rich.

Senegal (African) Gold Mines.—Whilst England and America are reaping the harvest of their recently discovered auriferous districts, France is not altogether inactive in the race for gold. Recent letters from St. Louis, in Senegal, announce the visit made by the governor to the gold mines at Bamhouk, 250 leagues distant. After inspecting them, he entered into arrangements for getting them worked. He also concluded a treaty with a native chief named Fougoul, of Farabana, who possesses a sort of suzerainty over the gold mines district: by this treaty the chief concedes to the French the right of working the mines in conjunction with the natives.

New Coal Mine in Downshire (Ireland).—The "Banner of Ulster" announces the discovery of a valuable coal-field at Tullygirvan, near Saintfield, on the property of Messrs. R. and S. Walker. The coal closely resembles that species of anthracite peculiar to Pennsylvania, and the newly-discovered beds in Australia. It is interspersed with silurian rock, which shows well-defined fossils of the graphtolite species (sea pens) and other shells. The surface-coal is also intermingled with a small proportion of plumbago (black lead), and shows a considerable per-centage of iron pyrites—largely used in Belfast in the manufacture of bleaching acids. The breadth of the vein of coal at present uncovered, is upwards of 25 ft.; its depth unknown, as no shaft has been commenced; but it is estimated at 29 ft. in thickness. The newly-raised coal has been tested, and found equal to any Scotch coal of a similar description.

Discovery of Rock-salt in Prussia.—Stettin, October 28. A discovery of the utmost importance for the trade of Prussia, and the countries on the Baltic generally, has been made at a place called Stopfurt, near this city, consisting of an inexhaustible bed of pure rock-salt. A small cargo has been sent this summer to Scotland, to be used in salting herrings; on trial, the quality has been pronounced even superior to the Liverpool rock-salt.

A Fatal Colliery Accident occurred, 29th October ult., in one of the Coltness Iron Company's pits at Coltness. Two men were in the act of filling a hutch, when about 20 tons of coal came away on them, and killed them on the spot.

The New Iron-stone Field in Yorkshire.—At the recent meeting of the British Association, Professor Phillips announced that the lately opened iron-stone field of the north-east of Yorkshire is likely to last 2,000 years.

Fatal Coal-pit Accident—Inundation.—At the Cae coal-pit, near Llanelly, Carmarthenshire, on the afternoon of the 4th November ult., a rush of water from the old adjoining workings inundated the pit, in which were 15 colliers; five escaped, and ten were drowned.

Australian Quartz Crushing.—"Port Philip and Colonial Company." The quantity of quartz crushed during August was 1,056 tons; received for crushing £2,256 15s.; expenditure, £1,589 6s. 3d.; profit, £667 8s. 9d. Assay office, (Melbourne), 35,948 ounces melted. The machinery had crushed during the last week (advices dated 14th September ult.) 370 tons.

Copper.—"English and Australian Company." By advices from Adelaide, to 10th September ult., six furnaces at work, almost wholly on wood, and working well. Labour abundant. Stock of coal at Gwaler, nearly 2,000 tons.

White-Brass or Unoxidizable Iron.—A new alloy, the invention of Mr. Sorel of Paris, has been introduced for casting vases, statues, and other objects of artistic character. It has the appearance and fracture of ordinary zinc, but it is as hard as copper or iron, being tougher than cast iron. It may be turned, filed, or drilled as easily as those metals; does not adhere to metal moulds, and retains its metallic lustre perfectly in a moist atmosphere. The alloy is prepared by melting together zinc, copper, and cast-iron—it contains 10 per cent. copper, and 10 per cent. iron.

The Iron Trade in France.—One of the principal organs of the Ironmasters' interest in France recently remarks,—"At Paris two years ago the price of coke iron, such as that of Commentry and of the Nord, was from 30 fr. to 38 fr. the 100 kilogrammes, and the wood iron (charcoal iron) of Burgundy and Champagne, 40 fr. Recently the prices have been 28 fr. and 30 fr. respectively. There is another kind of iron, that of the South, which is sold at 26 fr. Under these conditions English competition could not stand the struggle, when subjected to the customs' dues established by the law of July, 1856, and *no import of foreign iron with payment of duties now takes place.*" . . . . "The interests of the consumers, &c., are sufficiently satisfied with the present state of things. Can the ironmasters continne to support the present low prices? We wish it, but without positively expecting that they can."

English and Belgian Iron in France.—From recent accounts received from the (French) manufacturing districts, it appears that a vast quantity of English and Belgian iron has been imported into France in anticipation of the decree of the 17th October, 1855, not being renewed. That decree, *which has been suffered to expire*, admitted foreign iron into France, free of duty, on condition that it should be used in the construction of ships, or in articles to be afterwards re-imported.

Zinc.—In the "Mineral Statistics" it is officially stated that the British zinc ores are more eagerly sought for, and, consequently, command an improved price; that much attention has been directed to the metallurgy of zinc; and smelting processes, which promise both economy and dispatch, are being introduced.

Value of the Mineral Produce of the United Kingdom in 1857 (excepting clays and sandstones):—

Tin ore	£ 743,508
Copper ore, the produce of all the sales, excluding foreign ores, but including private contract purchases	1,560,922
Lead ore (as sold, containing silver)	1,428,095
Zinc ore	30,982
Iron Pyrites	63,804
Arsenic	919
Nickel and Cobalt	219
Iron ore	5,265,304
Coals	16,348,676
Salt	506,720
Barytes and other minerals	12,500
	£25,961,649

The values of the metals, as obtained from the furnace at the market prices of the year, have amounted to the following sums:—Tin £867,680; copper £2,166,900; lead £1,523,852; silver £133,216; zinc £450,000; pig-iron £12,838,560; other metals £125,500; total £18,105,708. Such, say the official "Mineral Statistics," to which we have already alluded, is a faithful representation, within very small and unavoidable limits of error, of the important mineral industries of these islands.

Fatal Accident (from Blasting) in a Coalpit.—At the works of the Thrybergh Coal Company, Kilnhurst, near Rotherham, on the 12th November ult., an accident occurred, attended with the loss of two lives, and serious injury to a third sufferer. A new shaft is being sunk on the estate, and blasting operations are indispensable from the nature of the strata to be excavated. Three men were lowered, and having laid the powder and lighted the fusee, had signalled to be drawn np. Owing to some mismanagement the signal was not responded to, or, at all events, not with sufficient promptitude; after the cage had, at last, begun to move up, it oscillated violently, and, soon after, caught against some obstruction in the shaft, and capsized. Two of the men fell to the bottom, the third clung to the rope, and succeeded in reaching the top; but, before he did so, the powder below exploded, and the two men in the shaft were blown to pieces, and their remains scattered in all directions. Inquest held at Kilnhurst on following day. Verdict "accidental death."

Another Accident from Blasting, fortunately unattended with serious injury, but suggestive of the necessity for the utmost care in those operations, occurred about the same time at the quarries adjoining St. George's Hall, Plymouth. A large blast had been intended for displacing a mass of overhanging rock. When the blast took place, a quantity of large-sized stones were hurled over the houses in the neighbourhood; one of the stones, weighing between 30 and 40 lbs., after being thrown up to a great height, fell on the roof of a house, and thence through to a room on the ground-floor, completely smashing a work-table at which, only a few minutes previously, the lady of the house had been sitting.

APPLIED CHEMISTRY, &c.

Aluminium.—By a recently patented process, M. Corbelli extracts aluminium from its compounds, and obtains, at the same time, proto-chloride of mercury. He takes rock-alum and chloride of calcium, or rock-alum and chloride of sodium, or sulphate of alumina and chloride of calcium (or instead of these, other salts having alumina for their base), well dries and pulverizes the mixture, and dissolves it in water; the liquid is then filtered, and placed with fluid mercury in a non-conducting vessel, and a weak current of electricity is passed through the two. The salts of alumina are thus decomposed, and the aluminium is deposited upon the zinc plate of the battery; proto-chloride of mercury (calomel) will also be deposited at the bottom of the vessel.

Acetate of Alumine.—Waterproof Clothing.—According to the "Moniteur Industriel" 20,000 tunics prepared, *i. e.* rendered waterproof by the following method of "*Impermeabilisation*," were distributed to the troops during the Crimean war. Take one kilogramme of alum, which dissolve, cold, in 32 litres of river or fountain water; in like manner, dissolve one kilogramme of acetate of lead in an equal quantity of water; a precipitate in the form of powder (sulphate of lead) is obtained. Stir the mixtnre several times during the day, and let it rest. Next day, decanter the liquid which retains acetate of alumine in solution; into this place the cloth or stuff, &c., to be rendered waterproof. That the cloth may be well saturated with the liquid, it should be left in for upwards of an hour, and turned frequently. On being withdrawn, it should be placed in fresh water to remove all smell and stiffness, care being taken not to twist or crumple it; it is then to be dried in the shade.

LIST OF NEW PATENTS AND DESIGNS FOR ARTICLES OF UTILITY.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

Dated 30th June, 1858.

1472. B. Nicoll, 42 Regent-circus—Circular knives and saws.

Dated 16th August, 1858.

1870. P. Richard, 17 Rue St. Jean, Faubourg St. Germain, Paris—Apparatus for obtaining motive power.

Dated 25th August, 1858.

1928. J. Dredge, Walcot, Bath—Condensers for steam engines and pumps for working such condensers.

Dated 26th August, 1858.

1936. G. M. Sautter, 14, Boulevart Montmartre, Paris—Telegraphs.

Dated 1st September, 1858.

1988. A. V. Newton, 66, Chancery-la.—Manufacture of alumina.

Dated 10th September, 1858.

2050. J. L. Chester, Philadelphia, U.S.—Self-priming apparatus for fire-arms.

2054. J. H. Johnson, 47, Lincoln's-inn-fields—Jacquard machines.

Dated 11th September, 1858.

2062. W. Baker, Kingston-upon-Hull—Preparing food.

2064. J. M. Courtauld, Braintree, Essex—Clearing and preparing silk crapes, aerophanes and other like fabrics.

Dated 13th September, 1858.
2076. R. Frost, Steam Mills, and A. Rigg, Park-gate-road, Chester—Apparatus for cleaning grain or seeds and bran.
Dated 14th September, 1858.
2084. W. J. Hoyle, Huddersfield, and R. Howson, Lancaster—Apparatus for signalling by sound.
Dated 18th September, 1858.
2104. G. Ostermoor, 37, Basinghall-street—Ornamenting boas, victorines, and muffs.
Dated 20th September, 1858.
2112. J. L. Chester, Philadelphia, U.S.—Cartridge opener and ramrod fastener.
Dated 22nd September, 1858.
2132. C. W. Harrison, Woolwich—Filters for purifying air and liquids.
Dated 24th September, 1858.
2144. E. T. Wright, Wolverhampton—Apparatus for preventing the explosion of, or injury to, steam boilers through deficiency of water.
Dated 25th September, 1858.
5152. A. F. Delacroix, Chartres, France—Locomotive engines.
2156. C. Hall, Navestock, Essex—Apparatus for applying power to the cultivation of the soil.
2158. J. C. Dieulafait, 2, Rue Sainte Appoline, Paris—A kind of garment which may receive different forms according to the will of the wearer.
Dated 27th September, 1858.
2160. X. Boutleville, Paris—Neckcloth or tie, means of connecting ties to collars and bands.
Dated 28th September, 1858.
2164. E. Lewthwaite, Halifax, and G. Ambler, Queen's-head, near Halifax—Clocks, watches, chronometers, and other timepieces.
2166. J. H. Linsey, 4, Grocers' Hall-court — Binding or covering books.
2168. J. L. Clark, Adelaide-road, Haverstock-hill—Coiling and securing telegraph cables preparatory to laying them from ships or vessels.
Dated 29th September, 1858.
2170. J. Luis, 1B, Welbeck-st., Cavendish-square—Fixing pastel pictures.
Dated 30th September, 1858.
2173. T. Britt, 9, St. Thomas-ter., Church-st., Old Kent-rd. Camberwell—Propelling of steam-boats.
2174. J. Wright, Birmingham — Mode of arranging and moving fire-bars for locomotive, puddling, and other furnaces.
2175. J. Morrison, Birmingham—Sewing machines.
2176. S. Taylor, Rochdale, Lancashire—Apparatus to be used as a fire-escape.
2177. L. Cecconi, 12, Great Newport-st. — Construction of cornets, trumpets, horns, and other wind instruments of a like nature.
2178. H. Kinsey, W. H. Morrison, and S. Smithard, Nottingham—Apparatus for the purpose of folding lace or other fabric.
2179. R. Levy, Manchester—Manufacture of coats, ladies' riding habits, and other similar garments.
2180. C. W. Siemens, John-street, Adelphi—Electric telegraphs.
2181. A Normand, Havre, France—Ships and vessels propelled by screw or such like propellers.
2182. G. Uhlhorn, Grevenbroich, near Cologne, Prussia—applying motive power to give motion to machinery.
2183. J. J. Russell, Wednesbury, Staffordshire—Furnaces for heating iron and steel.
2184. F. J. Money, Thaxted, Essex—Construction and adaptation of sewers.
Dated 1st October, 1858.
2185. W. Blake, 16 Harley-street—Portable fire-escape.
2186. J. T. P. Newbon and T. Smith, 62 Fenchurch-street, and J. Brown, 37 Tollit-street, Mile End—Method of lifting and lowering ships' anchors.
2187. M. Hipp, Berne, Switzerland—Electric telegraphs.
2188. J. W. Wilkins, Temple-chambers, Fleet-street, and J. B. Dunn, Great Winchester-street—Constructing electric telegraph cables.
2189. Sir E. Belcher, 40 Charing-cross — Manufacture of telegraphic cables.
2191. H. Bradbury, Whitefriars — Producing printing surfaces from engraved plates.
Dated 2nd October, 1858.
2192. J. Rogers, 9 Queen-square, Bartholomew-close—Submarine electric telegraph cables.
2193. L. D. Owen, 192, Tottenham-court-road—Ploughs for digging up potatoes.
2194. W. Brierley, senr., Cleckheaton, Yorkshire—Looms for weaving carpets and other fabrics.
2195. H. Monier, 2 Francis-street, Golden-square—A new gas burner.
2196. B. Samuelson, Banbury—Wheels of carts and other carriages to be used on common roads.
2197. H. G. Collins, Paternoster-row—Production of blocks or surfaces to be used in printing.
2198. J. C. Holman, London-street, and E. W. Holman, Grafton-street, Fitzroy-square—An improved pianoforte action.
2199. A. V. Newton, 66, Chancery-lane — Governor for marine and other steam engines.
2200. S. Stimpson, Lower-road, Islington—Construction of fagot or fire lighter.
Dated 4th October, 1858.
2201. R. Dolby, and J. Gates, Liverpool—Process of transfer printing and ornamenting on glass.
2202. L. A. Normandy, jun., 67, Judd-street—Apparatus for the prevention of boilers exploding from a deficiency of water.
2203. L. A. Normandy, jun., 67, Judd-street — Manufacture of sulphate of copper.
2204. M. Van Peteghem, Ghent, Belgium—Looms for weaving figured fabrics.
2205. F. Trevithick, Penzance, Cornwall — Applying sails and keels to boats and vessels.
Dated 5th October, 1858.
2206. J. Mills, Manchester—Apparatus for roving, slubbing, or spinning cotton.
2207. A. Bessemer, Upper Holloway — Manufacture of iron and steel.
2208. Major C. E. Oldershaw, R.A., Aldershot—Electric-telegraph cables.
2209. W. Menelaus, Dowlais Iron Works, Glamorganshire—Machinery for straightening rails and wrought-iron bars.
2210. M. Henry, 84, Fleet-st. — Arrangements for working steam expansively.
2211. J. H. Brown, Abbey Mills, Romsey, Hants —Manufacture of projectiles.
2212. G. Hamilton, St. Martin's-le-Grand, and W. Nash, Poplar—locks.
2213. J. H. Brown, Abbey Mills, Romsey, Hants—Manufacture of cartridges,
2214. J. Milnes, Sutton Mill, Cross Hills, near Leeds, Yorkshire—Weaving fabrics where cross weaving is employed.
2215. G. Lovett, East-st., Manchester-square—Portable apparatus for administering hot air, vapour, and shower baths.
2216. M. Jacoby and F. R. Ensor, Nottingham—Manufacture of bobbin-net or twist lace, and other fabrics made in twist lace machines.
Dated 6th October, 1858.
2217. J. Luis, 1B, Welbeck-st., Cavendish-square — Method of joining sheet-iron, cast-iron, gutta-percha, and other tubes, by means of muffles.
2218. G. Heppell, Newcastle-on-Tyne — Construction of boilers, furnaces, and flues.
2219. G. Collier, Halifax—Winding machines.
2220. M. Harnett, Moreton-st., Pimlico—Preventing incrustation in steam-boilers.
2221. C. Hill, Great Western Railway, Chippenham Station —Omnibuses and apparatus for upholding the windows of omnibuses and other carriages.
2222. J. Ridsdale, Stoke Newington—An improved reservoir or fountain pen.
2223. W. Mauam, Clapham-road, Surrey—Apparatus for the manufacture of gas.
2224. D. Scattergood and R. W. Smith, Nottingham—Manufacture of looped fabrics.
2225. C. Baylis, Poultry, London — Constructing and arranging underground chambers in populous cities or towns, for the reception of gas and water pipes, and telegraph wires.
Dated 7th October, 1858.
2226. D. Nicoll, 114, Regent-st.—Manufacture of cloaks and other garments.
2227. C. H. Thurnham, Dalston — Application of certain mechanical arrangements to be adapted to the wheels of locomotives, carriages, and other vehicles, for facilitating their traction or draught.
2228. E. J. Seyd, and J. W. N. Brewer, City of London—Preparation of paper to render writing thereon indelible.
2229. J. C. Nouveau, 2, Rue Sainte Appoline, Paris—Stopping bottles and other vessels containing non-gaseous liquids.
2230. D. Naylor, Stockport—Looms for weaving carpets and other fabrics.
2231. N. Fellowes, jun., West Derby, Lancashire — Tea kettles and other like domestic vessels.
2232. F. Ransome, Ipswich—Preserving wood.
2233. E. R. Handcock, 57, Pall-mall, Westminster—Machinery applicable to engines to be worked by steam and other motive power.
Dated 8th October, 1858.
2234. J. Luis, 1B, Welbeck-st., Cavendish-square — A new cutting and stamping-press.
2235. J. Leetch, Margaret-st., Cavendish-sq.—Method of constructing fire-arms.
2237. T. Waller, Rose-lane, Ratcliff—Stoves and fire-places for the prevention of smoke and the better ventilation of apartments.
2238. J. Mitchell, H. Mitchell, and T. England, Bradford—Apparatus employed in spinning wool, mohair, alpaca, silk, and other fibrous substances.
2239. R. Searle, Woodford Wells, Essex—Insulating and preserving and laying submarine and other telegraphic wires or cables.
2240. A. Nicholls, Manchester, and T. Walker, Birmingham —Spring-hook, catch, or fastening.
2241. W. A. Munn, Throwley-house, near Feversham, Kent —Horse-hoes.
2242. T. Roberts and J. Dale, Manchester—Process for obtaining salts of soda and other alkalies.
2243. C. W. Lancaster, New Bond-st.—A metal or metallic alloy especially adapted to the manufacture of fire arms and ordnance.
2244. A. Felton, 184, Brick-lane, Spitalfields—Instruments used for inserting and fixing metal eyelets.
2245. J. T. Smith, Gray's-inn—Electric cables.
2246. E. Birchley, Upper Severn-terrace, Worcester—Construction of cartridge.
2247. F. W. Gerhard, Tichborne-street, Haymarket—Manufacture of alluminium and sodium.
Dated 9th October, 1858.
2248. A. E. Galliard, 2, Seymour-place, St. James Churchyard, Clerkenwell—Making self-supplying portable fountains to play water or water perfumed.
2250. J. Tatlock, Hookersbrook, near Chester — Electric telegraphs.
2261. L. Hope, Bishopsgate Churchyard—Electric telegraph cables.
2252. W. Crofts, Lenton-terrace, Park Side, Nottingham—Manufacture of fabrics by bobbin-net or twist lace machinery.
2253. J. B. Pascoe and J. R. Thomas, Chacewater, Cornwall —Condensing and gassing smoke.
2254. J. Scrimshaw, 13 Johnson-st., Sheffield—Pumps.
Dated 11th October, 1858.
2255. A. Miller, Glasgow—Locomotive steam engines.
2256. J. Holroyd, Leeds—Knives used for shearing woollen cloths, and cloths made of wool and other materials.
2957. C. F. Vasserot, 45, Essex-st., Strand—Constructing reflectors.
2259. J. Beattie, Lawn-place, South Lambeth—Locomotive and other steam engines.
2260. R. Cowen, jun., Nottingham—Dressing lace and other fabrics made of silk, cotton, or other material.
2261. J. L. Hancock and F. L. Hancock, Pentonville—Implements for tilling, breaking up, or pulverising land, for sowing seeds, and for thinning out turnips and other crops.
2262. J. England. Charles-st., Fitzroy-sq.—Apparatus for cleaning the plates used in photography.
2263. J. Platt, Audlem, Chester—Locks.
2264. J. Nicholson, junr., Meadow-st. Works, Sheffield—Machinery for cutting and winding strips or shreds of steel, silver, or other metal used for ladies' dresses and other purposes.
2266. T. Riddell, Carocou-terrace, Old Ford, Bow—Arrangement for sustaining window sashes and sliding panels.
2267. M. Stow, Leeds—Securing the detection of alterations or erasures in bankers' cheques and other similar instruments, and the crossings thereof.
2268. W. E. Newton, 66 Chancery-lane — Apparatus for facilitating submarine explorations.
Dated 12th October, 1858.
2269. J. F. Swinburn, Birmingham—Fire-arms.
2270. L. Wray, 5, Devonshire-st., Portland-pl.—Coating or insulating submarine electric telegraph wires, and which are also applicable to the coating or insulating of electric telegraph wires laid underground.
2271. T. C. Shaw, and F. H. Cooper, Hanley, Staffordshire—Mode of working engines by the agency of air or gases in conjunction with electricity for obtaining motive power.
2272. W. Johnston and W. Ross, Glasgow—Water-closets and taps or valves.
2273. W. Smith, Edinburgh—Transferring drawings or delineations in lithographic and zincographic processes.
2274. Capt. G. Beadon, R.N., Bathpool, Somerset—Construction of ships, boats, rafts, and vessels for passing through water, or through the atmosphere, or partly through the water and partly through the atmosphere.
2275. J. A. Gasse, Paris—Railway breaks.
2276. H. W. Cutbbertson and G. Cuthbertson, Dundas-st., Monkwearmouth, Sunderland—Lever purchases for ships, windlasses, pumps, and other similar purposes.
Dated 13th October, 1858.
2278. J. Parkins, 1, Hanway-st., Oxford-st. — Securing envelopes.
2279. H. Parker, Sledmere Castle, Yorkshire—Apparatus for the cultivation of land.
2280. R. Ridley, Low Wortley, Yorkshire—Safety cages for mine shafts.
2281. W. H. Treacher, Blackfriars-road—Respirators.
2282. A. G. Bradby, Reading, Berkshire—Collars and ties, or other like articles of dress.
2283. A. Benda, 79, Basinghall-st.—Manufacture of models of the human and other figures to be used as toys for tuition.
2284. J. Braby and J. Braby, jun., Bridge House-pl., Newington causeway, Southwark — Wheels and wheeled carriages to be propelled by steam, horse, or other power.
Dated 14th October, 1858.
2285. J. C. Ollerenshaw, Manchester—"Cotton gins."
2286. H. Liddle and J. Booth, Tonge, near Middleton, Lancashire—Apparatus for polishing and finishing yarns or threads.
2287. L. Cowell, Adelphi—Apparel affording the means for preserving life at sea.
2288. C. Cowper, 20, Southampton-buildings, Chancery-la.—Manufacture of articles of hard vulcanized india-rubber, gutta-percha, and similar gums.
2289. A. Gordon, Little Fife-house, Whitehall—Manufacturing cast iron, steel, and wrought iron.
2290. J. R. Smith, Glasgow—Apparatus for propelling boats and vessels.
2291. T. Ingram, Bradford, Yorkshire—Apparatus for signalling between the parts of a train of carriages.
2292. W. Clark, 53, Chancery-la.—Tanning hides and in apparatus employed therein.
2293. S. Perkes, Clapham—Extracting oil from the cocoa nut and other vegetable matters.
2294. H. Martin, Old Kent-rd.—Separating starch from gluten.

2295. G. Baxter, Northampton-sq.—Colouring photographic pictures.
2296. T. Archer, jun., Dunston, near Gateshead—Apparatus for preventing explosions of steam boilers.
2297. S. Diggle, Radcliffe, Lancashire—Looms for weaving.
2298. W. E. Newton, 66, Chancery-la.—Construction of cabin or state room for steam boats and other vessels.
2299. J. Lomas, Manchester—Production of ornamental fabrics for ladies' dresses.

Dated 15th October, 1858.

2300. R. R. Jackson, Blackburn, Lancashire—Sizeing yarn.
2301. W. Bacon, Prestwich, Lancashire—Mode of constructing valves, valve cocks, gates, and stopcocks, which may be used in steam engineering.
2302. G. Davies, 1, Serle-st., Lincoln's-inn—Manufacture of gloves.
2303. T. Moore, Sheffield—Refrigerators.
2304. S. T. Clarke, 30, Kildare-ter., Westbourne-park—Crossing bankers' cheques and drafts.
2305. J. Wainwright, Birkenhead—Respirators.
2306. G. T. Bousfield, Loughborough-park, Brixton—Cutting the threads of wood screws.
2307. G. F. Wilson, Belmont, Vauxhall—Preparing compounds containing sulphur for preventing and destroying blight mildew, and insects.

Dated 16th October, 1858.

2308. L. Marcus, Algiers—Reaping machine.
2309. F. J. Coulon and S. G. Giraud, 2, Rue Sainte-Appoline, Paris—Ornamenting skin and leather.
2310. T. W. G. Treeby, 1, Westbourne-ter. Villas, Paddington—Breech-loading fire-arms and cannon.
2311. H. Francis, 456, West Strand, Westminster—Machinery for making the springs of surgical trusses.
2312. J. P. Gillard, Paris—Generating hydrogen, and apparatus for applying the same to heating and lighting purposes.
2313. J. Hick, W. Hargreaves, and R. Harwood, Bolton-le-Moors, Lancashire—Governors or regulators for prime movers.
2314. P. Jensen, Mount-gardens, Westminster-rd., Lambeth—Apparatus for governing or regulating the speed of marine engines.
2315. A. Robertson, Lounsdale, Renfrew, N.B.—Applying starch and similar matters.
2316. A. Dunn, Dalston-ter. East—Marking compounds to be used on linen and other fabrics.
2317. B. Nickels, Mitcham, Surrey—Electric telegraphs.

Dated 18th October, 1858.

2318. W. Clay, Ellesmere, Shropshire—Combined thrashing and dressing machines.
2319. J. A. Mason, Wirksworth, Derbyshire—Washing machines and apparatus for wringing and mangling.
2320. W. A. F. Powell, Bristol—Stopping or closing jars and bottles.
2321. C. West, 15, Mornington-st., Camberwell New-rd.—Mode of insulating and covering wire.
2322. R. Tidman, Jermyn-st., St. James's—Apparatus for paying out and for raising electric telegraph cables.
2333. R. A. Brooman, 166, Fleet-st.—Small chains.
2324. K. H. Cornish, 17, Chapel-st. East, May Fair—A new mode of advertising.
2325. W. E. Newton, 66, Chancery-la —Apparatus for lighting gas and other lamps.
2326. A. W. Drayson, Capt. R.A., Plumstead, Kent, and C. R. Binney, Capt. R.E., Woolwich—Submarine telegraphic cables.
2327. J. Smith, Newport, Salop—Rough-shoeing beasts of draught and burden.

Dated 19th October, 1858.

2329. J. Whitworth, Manchester—Guns, gun-carriages, and ammunition.
2330. W. F. Batho and E. M. Bauer, Salford—Screws, worms, and wheels, and machinery for cutting the same.
2331. J. Owen and H. Duckworth, Blackburn, Lancashire—Looms.
2332. A. Allan, T. Whimster, and R. Gray, Perth—Steam boilers.
2333. J. Richmond, 21, Carlisle-ter., Fairfield-rd., Bow—Construction of valves applicable especially to water meters, and other instruments for measuring fluids.

Dated 20th October, 1858.

2334. W. E. Newton, 66, Chancery-la.—Apparatus for washing clothes and other articles.
2335. W. E. Newton, 66, Chancery-la.—Hanging and arranging of cylindrical, conical, or spiral steel railroad springs for railway carriages.
2336. W. Gossage, Widnes, Lancashire—Utilization of alkali waste.
2337. R. A. Brooman, 166, Fleet-st.—Propelling vessels.
2338. Capt. J. Grant, Hyde-park-st.—Constructing and arranging ovens suitable for baking bread.
3339. W. Riddle, 1, Westbourne-ter., Barnsbury-park—Packing or forming merchandise or goods into bales.
2340. L. Stiebel, London, and C. F. O. Glassford, Greenwich—Moulding washing blues and other materials while in a plastic state.
2341. R. D. Clegg, Manchester—Screws.
2343. R. Griffiths, 69, Mornington-rd. Regent's-park—Baths.
2344. T. Twells, Nottingham—Machinery for embroidering or ornamenting woven, looped, or laced fabrics.
2345. J. Wainwright, Birkenhead—Ventilating houses and other places.
2346. S. T. Clark, 30, Kildare-ter. Westbourne-park—Apparatus for crossing bankers' cheques and drafts.

Dated 21st October, 1858.

2347. C. C. Alger, Parliament-st. Westminster — Cupola furnaces.
2348. J. Marland and S. Marland, Sun Vale Iron Works, Walsden, Lancashire—Power looms.
2349. P. Clerc and A. Piaget, 4, Newcastle-pl. Clerkenwell—Method of winding watches, chronometers, and time-pieces, without the use of a separate key.
2351. J. M. Napier, York-rd. Lambeth—Printing presses and printing machines.
2353. G. Redford, Moseley, Worcestershire—A circular and self-acting cartridge pouch.
2354. J. Baldwin, jun. Birmingham—Holders for papers, letters, bags, and other similar articles.
2355. R. A. Brooman, 166, Fleet-st.—Knitting frames.
2356. R. A. Brooman, 166, Fleet-st.—Apparatuses for regulating the supply of fluids.
2357. R. A. Brooman, 166, Fleet-st.—Cocks, taps, and other apparatuses for regulating the flow of fluids.
2358. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for lubricating railway axles and other bearings.

Dated 22nd October, 1858.

2359. J. Burridge, 151, Great Portland-st.—Fire-lighters.
2361. J. Bagnall and W. Bagnall, Westbromwich, Staffordshire—Manufacture of iron.
2362. A. Shaw, the Earl's Field Works, Grantham, Lincolnshire—Mode of raising nap on the linings of sheep skins.
2363. R. Waller, 50, Baker-st. Portman-sq. — Obtaining motive power.
2364. R. Kennedy and J. Armstrong, Lisburn, Ireland—Kiln for drying grain.
2365. C. Clay, Walton-grange, Wakefield—Apparatus for harrowing, scarifying, and cultivating land.

Dated 23rd October, 1858.

2366. Edwin Palmer and Edward Palmer, Thetford—Apparatus for cutting hay, straw, or other similar substances.
2367. P. C. Stortz, Havelock-buildings, Bold-st. Liverpool—Taking life-size pictures from smaller pictures, either with or without the aid of photography.
2368. E. C. Shepard, Jermyn-st. Westminster — Electric lamps.
2369. R. Bodmer, 2, Thavies-inn, Holborn—Toy or plaything for children.
2370. G. Davies, 1, Serle-st. Lincoln's-inn—Weaving.
2371. J. C. Martin, Fern-cottage, Charlewood-rd. Putney—Manufacture of metal moulds for moulding plastic substances.
2372. W. E. Newton, 66, Chancery-la.—Pumps.
2373. W. E. Newton, 66, Chancery-la.—Telegraphic apparatus.

Dated 25th October, 1858.

2374. E. Cottam, Lower Belgrave-pl. Pimlico — Internal fittings of carriages.
2375. M. Mason, Manchester—Elevating stands or stages for the use of hosemen in extinguishing fires.
2376. J. J. Welch and J. S. Margetson, Cheapside—Manufacture of scarfs for gentlemen's wear.
2377. Capt. Fowke, R.E. Park-house, South Kensington—Umbrellas and parasols.
2378. J. Robb, Aberdeen—Propellers for ships and boats.
2379. T. Ashworth and J. Ashworth, Pendleton, Lancashire—Power-looms for weaving.
2380. W. Craddock and J. White, Archer-st. Saint James's—Connecting links of harness hames.
2381. G. Kent, High Holborn—Churn.
2382. A. V. Newton, 66, Chancery-la.—Manufacture of candles.
2383. S. R. Parkhurst, New York, U.S.—Cotton gins.

Dated 26th October, 1858.

2384. M. Mason, Manchester—Self-acting feeding machines, for all descriptions of steam or other letter-press printing machines.
2385. A. V. Newton, 66. Chancery-la.—Machinery for pulverising, kneading, pressing, and moulding clay and other plastic materials.
2386. C. Wieland, Warkworth-ter. Commercial-rd. Limehouse—Chronometers, watches, and such like timekeepers.

Dated 27th October, 1858.

2387. B. Goodfellow, Hyde, Chester—Steam engines.
2388. J. Luis, 1B, Welbeck-st., Cavendish-sq.—A new syphon water-wheel, receiving its water without destroying the water level.
2389. J. Luis, 1B, Welbeck-st., Cavendish-sq.—Machine for boring.
2390. J. Bleakley, Accrington, Lancashire—Boilers and flues, and methods of fixing the same.
2391. A. P. A. Beau, 152, Regent-st., London—A pocket stereoscope.
2392. J. Kinsey, Brighton—Steam engines and pumps.
2393. C. Cheyne, Great George st., Westminster—Construction of floors and ceilings.
2395. G. Speight, 19, Woodbridge-st., Clerkenwell—Ringlets for head-dresses or ornaments or additions to the natural hair.
2396. M. Mason, Manchester—Letter-press printing machines.
2397. P. G. Gardiner, New York—Furnaces for reheating steel, preparatory to hardening, tempering, or annealing.
2398. T. Almond, 22, Pickering-pl., Paddington—Furnaces for the better combustion of smoke.
2399. J. W. Mott, Lea Bridge-rd.—Pouches of india rubber for holding tobacco or other substances.

Dated 28th October, 1858.

2400. D. Varley, Over Darwen, Lancashire—An improved picker for looms.
2401. G. M. Casentini and J. O. Barnard, Hercules buildings, Lambeth—A certain composition to be used in the manufacture of articles composed of or made with plaster of Paris and other similar substances.
2402. P. G. Gardiner, New York—Apparatus for cooling and preserving an equable and low temperature in the oil or composition, or other fluid mixture used for the purposes of tempering, annealing, or hardening steel.
2403. J. Westerby, Upper Aspley, Huddersfield—Application of steam to vessels filled with oil, tallow, or other materials for lubricating the cylinders of steam engines of high or low pressure.
2404. C. Pooley, Manchester—Machines for preparing cotton and other fibrous materials.
2405. T. Railton, Manchester—Apparatus employed in the manufacture of cap or bonnet fronts.
2406. A. Heywood, Manchester—Apparatus for suspending paper and woven fabrics to be dried.
2407. J. Evans, Brewers' House, Nine Elms, Battersea—Lubricating the slide valves and pistons of steam engines and in apparatus for this purpose.
2408. B. Foster, Deuholme, near Bradford, and P. Smith, Keighley—Apparatus for spinning and doubling wool, alpaca, mohair, cotton, silk, flax, and other fibrous substances.
2040. W. Munro, 32, Bartholomew-close—Manufacture of capsules and other metallic articles.
2410. J. Smith, Bristol—Improved hats and coverings for the head.
2411. W. Hall and A. Wells, Erith—Electric telegraph cables.

Dated 29th October, 1858.

2412. P. Brunon, Paris—Manufacturing cocks.
2413. W. Kirrage, 10, Goulstone-buildings, Bermondsey New-rd.—Elastic combination of materials impervious to atmospheric influences.
2414. J. Dransfield, Water Head Mill, Oldham—Cocks, taps, and valves.
2415. P. Wright, Dudley, Worcestershire—Manufacture of anvils.
2416. W. E. Newton, 66, Chancery-la.—Method of attaching wheels to the axles of railway carriages.
2417. J. Dixon, Jersey City, U.S.—Manufacturing steel.
2418. J. Wright, 21, Bridge-st. Blackfriars—Application of machinery, to be used as a new motive propelling power.
2419. G. Zanni, Union-st., Barnet—Arranging magneto-electric machines for medical and other purposes.
2420. R. W. Chandler, Bow, and T. O. Hatfield, Hertfordshire—Agricultural apparatuses for ploughing and otherwise operating upon land.
2421. R. A. Brooman, 166, Fleet st.—Obtaining motive power.
2422. L. J. Lewis, New Bridge-st., Birmingham—Fastenings for ladies' dresses.
2423. J. Morris, Broughton, Salford, Lancashire—Manufacture of rollers or cylinders for printing fabrics.
2424. J. Drummond, Midlothian, N.B.—Reaping and mowing machines.
2425. J. H. Johnson, 47, Lincoln's-inn-fields—Photography, improvements in.

Dated 30th October, 1858.

2426. R. J. Coningsby, London—Apparatus for turning over the leaves of music or of books.
2427. E. T. Hughes, 123, Chancery-la.—Apparatus to prevent railway accidents.

Dated 1st November, 1858.

2429. G. Davies, 1, Serle-st., Lincoln's-inn—Machinery for weaving velvets and other piled fabrics.
2431. H. H. Henson and W. F. Henson, 38, Parliament-st.—Manufacture and treatment of starch for domestic purposes.
2433. J. Cariss, York—Safety switch-box and gear.
2435. C. Perley, New York, U.S.—Means for disconnecting boats from the davit blocks, and effecting other like objects.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

2352. E. B. Horn, Massachusetts, U.S.—Compensation apparatus for a hair-spring balance for a watch or timepiece.—21st October, 1858.

DESIGNS FOR ARTICLES OF UTILITY.

4123. Oct. 14. J. McLintock, Westgate-house, Barnsley, "Stay Fastener."
4124. „ 15. D. W. Lovell and A. Wilson, 9, Wine Office-court, Fleet-st., "The Horizontal Dome Inkstand."
4125. „ 15. J. Cramb, 52, Magdalen-yard-rd., Dundee, "Revolving Panoramic Stereoscope."
4126. „ 20. Easterbrook and Allcard, Albert Works, Sheffield, "Improved Bench Vice."
4127. „ 21. H. E. B. Farmer, Northampton, "Sprig for Binding Boot and Shoe Heels."
4128. „ 25. C. Brown, Market-pl., Leicester, "Brown's Improved Convex Washing Board."
4129. Nov. 2. D. Jones, Dartmouth-st., Birmingham, "Cinder Sifter."
4130. „ 3. J. Sadler and T. Davis, Birmingham, "Hinge."
4131. „ 4. E. P. Capper, West Maitland, New South Wales, Australia, "Well Bucket."